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Parsons, Brinckerhoff, Quade & Douglas
Title:
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Place:
[Detroit]
Date:
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Parsons, Brinckerhoff, Quade and Douglas.
Report on a rapid transit system for the city of Detroit, made to the Board of street railway commissioners, city of Detroit, by Barclay Parsons & Klapp. [New York?, 1918.
vii, 123 p. maps, diagrs., charts, fold. table. 29cm.

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REPORT
ON
A RAPID TRANSIT SYSTEM FOR THE CITY OF DETROIT

TO

BOARD OF STREET RAILWAY COMMISSIONERS
CITY OF DETROIT

BY

BARCLAY PARSONS & KLAPP, CONSULTING ENGINEERS

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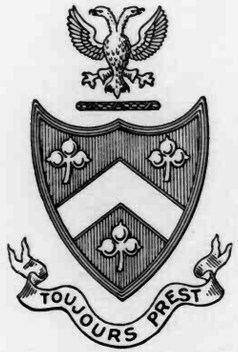

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REPORT ON

A RAPID TRANSIT SYSTEM FOR THE CITY OF DETROIT

MADE TO THE
BOARD OF STREET RAILWAY COMMISSIONERS
CITY OF DETROIT

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December 1st, 1917

THE HONORABLE BOARD OF STREET RAILWAY COMMISSIONERS,
CITY OF DETROIT.

DEAR SIRS:

We have the honor of handing you herewith our report on a Rapid Transit System for the City of Detroit in accordance with your instructions and as covered in our contract with you of May 21, 1917.

In our previous report to you under date of January, 1915, we included detail traffic counts on every car line in the City as well as car route maps and drawings showing subway construction details, rearrangement of sewers, etc., etc. These and similar matters, useful principally as a record and for future reference, we have not repeated in the present volume, taking it that both reports will be available to anyone wishing to go into questions of detail.

We call special attention to the financial chapter and the recommendations in this Report for joint City and Company ownership under commission control as a possible means of the City ultimately acquiring complete ownership of the system. This discussion is of the greatest importance at the present time when the financial condition of many city transportation systems throughout the country is so deplorable.

We wish to express again our sincere appreciation of the assistance and hearty co-operation of the City officials and their staffs, as well as that of the operating officers of the Detroit United Railway, in facilitating the investigations we have made in the preparation of this Report.

We are also indebted to the Appraisal Committee of the Detroit Real Estate Board for their courtesy in supplying carefully prepared appraisals of rights-of-way for proposed rapid transit lines through various parts of the City, which service they rendered gratis to the City.

Faithfully yours,

BARCLAY PARSONS & KLAPP,
Consulting Engineers.

REPORT ON

A RAPID TRANSIT SYSTEM

FOR THE CITY OF DETROIT

DIGEST OF REPORT

For the convenience of the general reader this digest or condensed statement of the main features of the Report has been prepared. Direct quotations from the full text of the Report have been made in some cases.

This Report is supplemental to, and in many respects a continuation of, the Report made in 1915 on the same general subject. The aim in the present Report has been to meet the Commissioner's request for a statement as to whether the growth of the City of Detroit, the increased traffic, and conditions of street congestion do not now warrant the initiation of a rapid transit program. Also, the effort is made to point out along what general lines a rapid transit system should be laid out for Detroit as it continues to grow. What steps should be taken in building up such a system to give immediate relief, and which will provide the nucleus of a general rapid transit system, are described.

The Report has been divided into five chapters.

CHAPTER I—GENERAL BASIS OF REPORT

This chapter treats of past population growth and increased area of the City, together with estimates of probable future increases in both of these important items. The analysis shows that Detroit started its rapid period of growth in 1880 when the population was 140,000, reaching by 1900 a size of 318,967, by 1910 a size of 500,982, and by 1917 about 850,000 people in the City and Suburbs. The prediction made in the 1915 Report of 1,000,000 population by 1920 is repeated and the further estimate of 2,000,000 population by 1950 is set forth as a reasonable basis of future traffic estimates. In estimating the population at intermediate dates the assumption is made that the population will increase by equal yearly increments from 1920 to 1950, as it is considered futile to attempt detailed predictions of the fluctuations which will certainly occur, but which cannot be determined accurately. See pages 17, 37 to 40, and 58 to 60.

The growth in street car traffic is traced by years on each of the surface street car lines from 1904 to 1917. The total passengers in 1904 are shown as 105,000,000, of which 78,000,000 were revenue and the balance transfer passengers. In 1917 the total passengers carried were 440,000,000, with 315,000,000 revenue, the transfers being about 39 per cent of the revenue passengers, as estimated by a 24 hour check of the whole system. By a comparison of population with revenue riders it is shown that in 1904 there were collected 248 fares for every person within the City, while in 1917 the fares per capita had increased to 361.

From these facts it is deduced that when the City has attained a population of 1,000,000 in 1920 there will be 370 revenue rides per capita and a total therefore, of 370,000,000 revenue rides per annum. The very conservative estimate is then made that from this point on the increase in rides per capita will be one per year instead of an average of from five to eight, as in previous years, and that in 1950, with a population of 2,000,000 and rides per capita of 400, there will be 800,000,000 revenue riders.

It is interesting to note that Boston commenced its rapid transit program when it reached approximately 830,000 population. The initial elevated railroad construction, the only form of rapid transit in Chicago, was commenced when the city was slightly over the 1,000,000 mark and Philadelphia's first rapid transit line was started when the city had approximately 1,400,000 population.

Detroit, in the matter of size, has therefore reached the stage where other cities entered upon their rapid transit development.

Upon the investigation of growth in population and traffic contained in this chapter is based the estimate of the transit facilities required and the earnings which may be reasonably expected.

> It is not intended here to urge the commencement of actual construction of subways in Detroit at such a time as the present, when all financial and construction resources are under the strain of a great war. It is intended, however, to point out that a considerable number of years must necessarily elapse between a decision to build and the commencement of successful operation, and that of this period much of the time must be employed in the working out of the details of agreement, specifications and plans, which would not involve expenditures of large amounts of money and which, when completed, would make immediate construction possible upon the resumption of normal conditions.

The summary of physical conditions, pages 34 to 35, gives briefly the findings from the investigation conducted during the past six months.

CHAPTER II—RAPID TRANSIT PLAN AND CONSTRUCTION PROGRAM

The question of locating the rapid transit lines so as to serve best the interest of the City as it grows, is here discussed from the point of view of the origin and destination of the riding public.

The residential distribution of the population is discussed in detail and the fact is pointed out that a line coinciding substantially with Woodward avenue divides the population of the City into two nearly equal parts, east and west of that line. It is further shown that an east and west line crossing Woodward avenue at about Ferry street, two and one-half miles north of the City Hall, divides the residential population into nearly equal parts north and south. It is also shown,

> * * * that there are an average of over 28,000 people per mile of line resident in a district extending one-half mile on either side of Woodward avenue for the first four miles north of Grand Circus. Similar districts adjacent to Gratiot avenue, show an average of 25,000 people per mile of line; along Michigan avenue, 20,000; Fort street, 16,000, and Jefferson avenue, 11,000 people. While it is true that dense residential districts do not always produce a proportionate number of passengers, nevertheless, the foregoing relative figures indicate clearly the importance of Woodward avenue and the east and west rapid transit line paralleling Michigan and Gratiot avenues.

Having thus located the residential end of the daily journeys of passengers, the places of employment are analyzed by discussion of locations of factory and business centers and from this analysis it is deduced that the City has been growing with remarkable uniformity over its entire area. The factories, or points of occupation, have been increasing along the railroads and decreasing along the Detroit river with a tendency to and prospect of great future growth in the western part of the City. The general shift of the residential population, since the last canvass and report, has been a spreading into the outlying districts, the location of densest population having moved outward from the center of the City a distance somewhat over one mile in the past three or four years.

An analysis of the building permits issued by the City during 1914-1915-1916 showed the greatest activity in this direction, building being concentrated particularly in the newly developed additions to the City and the outlying portions of the old City area.

Types of Rapid Transit Structures

From the discussion of the types of rapid transit construction the following is quoted:

> In order to lay out a financially possible system, which may be

realized within a reasonable length of time in such a situation as that presented by Detroit, the necessity for low construction cost is obvious.

In the heart of the City, where the congestion of vehicle and street car traffic and even pedestrian crossing traffic has become very serious, no other solution than by a subway system is possible. When, however, this extremely congested central district is relieved, further extension of subways seems of doubtful advisability as a general method of reaching the many outside residential districts of a radial city and for such extensions overhead railways are recommended.

On page 43, the subway transfer station at Grand Circus is illustrated, showing the north and south Woodward avenue and the east and west Michigan-Gratiot avenues subways on different levels.

An overhead structure is illustrated on page 44, with a single column placed in the center of the street for streets of over one hundred feet in width, thus combining the minimum of obstruction to light and access to adjoining properties. The cost of this structure is only about one-third that of a subway line. An overhead structure is also shown on page 45 on private right-of-way, the structure being so designed as to span the right-of-way, thus providing an additional vehicle highway, which could be utilized by trucks and commercial vehicles to great advantage. It is not possible to develop an adequate rapid transit system, self-supporting, on a moderate fare without this use of cheaper type of railways. This has been the history and is now the approved practice in other cities.

Woodward Avenue and Other Rapid Transit Lines

The unique situation of Woodward avenue as the main business thoroughfare of the City and its most densely trafficked surface car line is developed.

Taking into consideration the characteristics of the traffic growth previously discussed, the increases in and location of residential districts, as just mentioned, and the trend of factory location, it is seen that Woodward avenue is the heaviest trafficked, the most centrally located and the most rapidly growing thoroughfare in the City. Along its entire length it is becoming more and more a delivery district for passengers on the street itself, and the territory on either side is steadily increasing in population density. In all of these characteristics the increases, taken as a whole, are greater than on any other line.

On these grounds Woodward avenue is recommended as the initial rapid transit route.

The other possible rapid transit lines necessary for the City, as one district after another outgrows the capacity of the surface car system, are pointed out. On map No. 3 is seen the result of the successive building steps combined into a general rapid transit system intended to serve a population of

two million people. The City area indicated on this map is 156 square miles, practically double that within the present City limits. It is stated, that on account of the level nature of the country and the equal desirability of many districts surrounding the present City, a wide distribution of the residential population must be expected. The preponderance of one and two family detached homes and an average population density for the whole City of only twenty people per acre is predicted.

Building Program

The construction program is laid out covering the period up to 1950, see map No. 3. This period is divided into two sections, the first one being ten years for which definite lines are recommended while general recommendations are made for the second and subsequent period. It is pointed out as unwise to predict in detail the growth of the City beyond a very moderate term of years. The necessity for progressive building of rapid transit lines, as the City grows, is stated as follows:

It is, of course, obvious that the building of all of these lines immediately would be financially ruinous to whoever undertook to supply the money for financing such a project. The construction must, therefore, be contemplated in successive steps and of these Woodward avenue is the first, to be followed by an east and west line parallel with Michigan avenue and Gratiot avenue, as above described. The third step, present indications would suggest, would be a line to be located along or near Jefferson avenue. This line has many claims to preference in the way of a great proportion of long distance riders from the outlying districts, i. e., east of Belle Isle bridge as far as Grosse Pointe. The westerly end of this line, if extended beyond Woodward avenue along Fort street, does not at present make a good showing. This might, however, prove the best method of reaching the district that will undoubtedly grow up along the River Rouge in connection with the Ford tractor plant. This same district might, on the other hand, be reached from the Michigan avenue line.

The above routes are the most probable general arteries of travel along which rapid transit in the future will be justified. The route which at present can be considered fully warranted is that on Woodward avenue.

On diagram page 48 is shown the rapid transit system, which, under the conditions assumed in the financial plan, could be developed during the first ten years after a definite policy regarding the traction problem of the City is decided upon.

The high speed line on Woodward avenue is planned to be built first as far as Manchester avenue, the underground portion extending from Woodbridge street to north of Grand Boulevard. The short subway branches for the crosstown lines could be built next and might be used by certain street car lines for the purpose of re-

lieving the downtown congestion. These subway branches could then be extended for rapid transit and connected to overhead construction in the location and to the extent shown on diagram page 48, or as far as the financial situation, from time to time, may permit. In this manner it is intended to develop, as rapidly as consistent with a self-supporting system and good service, an initial set of rapid transit routes which will serve all parts of the City and which will be fed by transfer from a network of surface lines leading through and from the less densely settled districts of the City.

SURFACE AND INTERURBAN LINES

The utilization of surface lines as feeders by transfer to the proposed rapid transit lines is fully developed, and the running of the interurban cars over the rapid transit lines into the heart of the City is shown as a means both of relieving street congestion and improving the running time of these cars.

CHAPTER III—BASIS OF UNIFIED OPERATION

Commencing on page 51 and extending to page 56 is a discussion in which there are pointed out the advantages to the public of a unified system of surface and rapid transit lines. The convenience of being able for one fare to use both rapid transit and surface lines, by free transfer throughout the City, is obvious, as well as the time saved by such use of the system.

THE RATE OF FARE SHOULD BE MADE DEPENDENT UPON THE COST OF THE SERVICE

In Boston, on the unified surface, elevated and subway system, under rigid public service regulation, one dollar of revenue in 1897 was received upon $2.96 invested, while in 1916 this investment had increased to $6.39 for one dollar of annual revenue. With a fixed five cent fare the inevitable ultimate embarrassment of the company is obvious.

In the plan submitted in this Report it is proposed to make possible, under Commission regulation, a change in fare with change in cost of service. The limiting conditions are to be quality and quantity of service, the actual cost of operation, and a return on the investment, such as will secure the necessary capital for the undertaking.

SYSTEM TO BE SELF-SUPPORTING

The condition of maintaining, out of earnings, an adequate return on the investment over and above operating expenses, embodies the essential requirements of a self-supporting transportation system, as proposed herein.

Neither Detroit nor any other similar city can hope to secure the large amounts of capital necessary for the initial construction

period of a modern rapid transit system and to pay the fixed charges on such expenditures out of a fare below five cents.

The plan here laid out is estimated to be self-supporting on an average fare of five cents, with free transfers throughout the thirty year period up to 1950. This figure of five cents is used, not to indicate a fixed fare, but quite the contrary.

* * * it is proposed that this question of fare be placed under the control of the Street Railway Commission and the fare based upon the cost of the service.

CHAPTER IV—FINANCIAL PLAN

The financial plan is pointed out as essential to the creation of a rapid transit system for the City. The costs of modern rapid transit lines have become so high as to make financing of these projects extremely difficult. Unless great care is taken in protecting both the capital invested and the return on the same, the investing public cannot be induced to place their money in traction enterprises.

The absolute necessity of an increase of fare over that at present in effect on the street car system in Detroit, in order to support the proposed rapid transit system, is clearly seen. The enormous increase in investment and fixed charges necessary for this higher class of transportation facilities is indicated in the case of the Woodward avenue rapid transit line, by the following figures which are given to illustrate the relative construction costs and the annual interest charges on the existing surface car line as compared with a proposed elevated or subway line.

Woodward Avenue	Construction Cost	Annual Interest Charges at 6 per cent
2 track street car line	$ 625,000	$ 37,500
2 track elevated line	5,000,000	300,000
2 track subway line	15,000,000	900,000

It will be seen, therefore, that a two track elevated system of the improved type discussed in this Report would cost eight (8) times and the subway twenty-four (24) times as much as the existing surface car line. It must be remembered, furthermore, that the fixed charges on this new investment are an additional burden over and above that carried by the existing system, for we are here discussing a unified transportation system, rapid transit and surface, which shall be self-supporting. Assuming that the present city surface line system represents an investment of $30,000,000, it is obvious that a Woodward avenue subway would increase the fixed charges 50 per cent on the combined system. The addition of the first crosstown

rapid transit line, together with the necessary extensions of surface lines and rapid transit and surface line equipment, as proposed herein, would more than double the fixed charges.

COMPARISON OF COST AND FIXED CHARGES ON TRANSIT SYSTEM WITHOUT AND WITH RAPID TRANSIT

Item	System	Cost	Interest at 6 per cent
A	Present D. U. R. city surface lines and equipment	$30,000,000	$1,800,000
B	Item A, with Woodward avenue subway and elevated, and equipment	51,000,000	3,060,000
C	Item B, with an east and west subway and elevated, and equipment	68,000,000	4,080,000
D	Item C, with surface line extensions to facilitate transfers between rapid transit and surface lines	75,500,000	4,530,000

The City lines of the existing D. U. R. system, under their present rate of fare (six, seven and eight tickets for 25 cents), do not produce a revenue sufficient to pay more than a very moderate return on the foregoing valuation of $30,000,000, even with the heavily loaded street car service as at present given. The possibility of maintaining the present rate of fare is shown to be due to the constantly increasing number of total passengers per car mile with an equally steady falling off in the speed on practically every line in the city as shown by the operating statistics of this system on page 64 and graphically on diagram page 65.

The following arrangements are proposed as necessary to the successful financing of the unified transportation system.

A. A partnership to be created between the City and a company formed to take over the surface car lines of the D. U. R. within the City limits.

B. The City to build and own the rapid transit lines and the Company to build the surface line extensions and supply the equipment for the entire system.

Toward such a partnership, the City will contribute the funds necessary to build the rapid transit lines, whose cost is kept within the legal two per cent debt limit, and which structures thus built it is to own. Subsequent rapid transit construction is to be financed by the reinvestment in the new structures of the City's share in the surplus from operation. These accumulated sums will supply the bulk of the new funds for rapid transit construction and keep the bond issue well within the two per cent debt limit.

C. The new Company to operate the unified system under a terminable license until the system is taken over by the City under the terms of the partnership agreement.

D. The Company to supply and finance the surface lines and extensions and all equipment.

The Company will contribute the existing city street car system at a reasonable valuation as of the date of consolidation, and will furnish the capital for all the equipment of the rapid transit and surface lines and for all extensions of the street car system. The valuation assumed for the street railway system in 1917 is $30,000,000.

E. Only actual interest rate on City and company funds allowed.

Upon the capital invested by each partner they are to receive from the revenues the rate of interest, which they respectively must pay to secure their share of the required capital. In calculating the financial tables it was assumed that the interest rate upon the capital invested by the company will be not over six per cent. All securities are to be issued only upon approval by the Street Railway Commissioners as to amount, price and rate of interest.

A sinking fund to retire the bonds of both City and company in sixty years is also provided. The equity in the property, represented by the bonds retired through the operation of the sinking fund is to revert to the City.

F. The surplus earnings to be divided equally between City and Company.

The net income of the system, after setting aside the interest charges and the sinking fund, is to be divided equally between the City and the company, provided the company's return does not exceed eight per cent on its investment. The City's share in the net divisible surplus is to be subject to the payment of an agreed minimum to the company.

G. The whole system to be subject to purchase by the City at a given price.

A purchase price is to be set up for the entire system which shall consist of the City's outstanding securities, plus the value of the surface car lines at the time of the consolidation, plus such actual additions as are made from time to time by the company, reckoned at par value of the securities approved by the commissioners to cover these last two items, less those retired through the sinking fund. Common stock issued by the company is to have no par value and is not to be included in the purchase price. At the purchase price thus fixed, less the City's outstanding traction bonds, the City may on due notice take over the property at any time.

H. Ownership of property acquired by the City from its share in the earnings.

It is shown, that by the working of the sinking fund provision and the reinvestments of the City's share in the net divisible surplus, the ownership of the property will pass automatically to the City. The proposal is made

that, as the bonds of the company are amortized and retired, the equity represented by these bonds becomes the property of the City. In this manner it is shown that by 1930 the City could acquire, free of debt, the entire system, upon which had been expended $78,882,000, by the payment of $65,561,000. By 1940 the entire system would represent an investment under the proposed building program of $114,858,000 and this system the City could acquire, free of debt, for $71,760,000. By the end of the estimated period, 1950, the building program is shown to require the investment of $156,134,000. The system at this date could then be taken over by the City, free of debt, at a purchase price of $75,435,000, towards which there would then be accumulated a traction fund in the hands of the City of $25,642,000. By the use of this traction fund, only $50,000,000 additional cash would be required to complete the City's ownership of the $156,134,000 property.

A series of tables, pages 76 to 85, show in detail, the estimated expenditures for investment in the proposed unified traction system, the capitalization of the funds required by the City and by the company, the estimated gross operating revenue and operating income, the interest and sinking fund charges, and the distribution of the net divisible surplus between the City and the company. The net divisible surplus is shared equally by the City and by the company, with the limitation, however, that the company's total income, interest plus surplus, shall not be more than eight per cent nor less than six per cent on its outstanding securities.

Charts on pages 86, 87, 88 give in graphic form the same information as is shown in the financial tables.

On chart, page 87, the division of the outstanding investment between the City and the company shows the steady increase in ownership of the system by the City and the decrease of the company ownership. This use of the sinking fund as a joint means of protecting the bond issues and simultaneously acquiring ownership by the City, is particularly to be noted.

Chart, page 88, shows the subdivision of the gross operating revenue into operating expenses, interest charges, sinking funds, and the final division of the net surplus between the City and the company. The steady growth of the City's return is here clearly exhibited.

Following this detailed presentation of the actual working out of the proposed and recommended financial plan, an analysis is submitted of three alternative plans in which the difficulty, and in some cases, the impossibility of separate ownership of competing systems or immediate municipal ownership of the entire system is pointed out.

CHAPTER V—CONCLUSIONS AND RECOMMENDATIONS

In this chapter the conclusions derived from the analysis of the existing and the indicated future traffic situation are summarized. These conclusions definitely point toward the necessity of immediately adopting a rapid transit policy by the City of Detroit upon the principle of creating a self-supporting, unified system of progressively constructed rapid transit and surface lines. With the City's financial co-operation, such a system can be built and operated to the satisfaction of the public. Strict commission control will secure the best service at the lowest cost. The needed facilities for high speed lines and adequate service throughout the combined system cannot be financed without an increase of the fare above that now charged for surface car transportation.

In the recommendations, the full text of which is found on pages 92 to 95 a partnership agreement between the City of Detroit and a Company formed to take over the city lines of the Detroit United Railway is pointed out as the best means of obtaining a permanent solution of the City's traffic problem by a unified surface and rapid transit system. It is recommended that the building of subways be restricted to the congested central area of the City. Overhead high speed lines are planned for the outlying districts. The preliminary work connected with the construction of the rapid transit lines on Woodward avenue and on Michigan, Gratiot, Forest avenues is to be commenced at once. The extension of the powers of the Board of Street Railway Commissioners in order to enable them to control the traffic situation both as to construction and operation as well as to regulation of financing and fares, is shown to be a fundamental necessity for the success of the proposed plan.

APPENDICES

Appendices giving details of various traffic studies, statistics of the present surface lines, population, employment statistics and cost estimates, are bound in this volume following the text of the Report.

THE REPORT

REPORT ON
A RAPID TRANSIT SYSTEM FOR THE CITY OF DETROIT

INTRODUCTION

During the year 1914 we made an investigation of the traffic conditions on the street railway system of the City of Detroit in order to comply with the request of the Board of Street Railway Commissioners for an analysis of the causes leading up to the street railway congestion during rush hours and the overcrowding of certain lines, and for a definite recommendation as to whether or not a subway was justified under the then existing conditions in the City. A complete check was made of the traffic on all the street car lines of the City and an especially detailed traffic check was made on the Woodward avenue line.

The result of this investigation was embodied in the report delivered early in January, 1915, containing recommendations for the re-routing of the street car lines as a means of immediate relief, and the statement was made, that the traffic, at the existing rate of fare (seven tickets for 25 cents), would not support a subway line, even on Woodward avenue, the heaviest traffic street in the City. The fact, however, was pointed out that by an increase in fare on the entire system, the traffic to be anticipated, would, in a few years, support such a rapid transit line, if the City's growth continued at approximately the then existing rate.

In May, 1917, the Detroit Street Railway Commissioners advised us that in their opinion the City's growth had continued at such a high rate, and the congestion of street car traffic had so greatly increased, that they wished us to supplement the previous report by bringing down to date the 1914-1915 investigation in its most important features and to work out a definite rapid transit plan, which might be taken by them as a basis for the establishment of a rapid transit policy for the City.

In the present report, we have, therefore, directed our attention primarily to the development of a general plan based upon a conservative estimate of the probable future growth of the City and its consequent traffic, and the provision for meeting rapid transit needs along broad general lines. The traffic counts and studies made during 1914 and printed in the 1915 report have been brought up to date where applicable to the present problems.

The intention is to place before the Commissioners, the general basic facts bearing upon the question of whether or not a rapid transit system is justified and, if so, on what general lines it should be laid out.

The outline of the financial limitations, within which such a system must be restricted if it is to be self-supporting, and the alternative of the City assuming a financial burden to support rapid transit, is also set forth.

A Definite Rapid Transit Program Required

The problem of laying out a definite rapid transit system for a city of the size of Detroit, at a period when it is undergoing rapid changes and very unusual growth, demands the answer to two important questions:

(a) How extensive a rapid transit system is necessary and reasonable to serve properly the present and future needs of the City, having due regard to the requirements of the City's various districts, and;

(b) What financial measures must be adopted to raise the funds necessary for constructing and to secure the revenue for supporting such a system?

The first question involves a determination of what it is reasonable to expect will be the growth of Detroit in population and area during the next thirty years. The obvious impossibility of attaining detailed accuracy in a thirty-year prediction suggests the wisdom of dividing the physical plan into two periods:

1. A preliminary ten-year period for which a definite building program is developed, and;

2. A subsequent period for which a plan is made of great flexibility, so that the City's growth may be followed without abandoning the general program.

By laying out the initial ten-year rapid transit plan so as to form the nucleus for a greater city development, it will be possible to outline additions to be built during the second period, which, however, can be varied from time to time as the City's growth may, at later dates, prove necessary.

The second question, namely, that of finance, involves the determination of a definite policy upon which the securing of the necessary money for construction purposes may be obtained. This vital and absolutely fundamental question is treated at considerable length under the heading "Financial Plan."

It is realized fully that in these disturbed times both of these questions and their treatment are greatly complicated by the existing abnormal business, financial, and economic conditions of the whole country. The effort, however, has been made to lay down a general plan for both building and finance, which plan is believed to be fundamentally sound in principle and may be modified in detail when actually put into effect. Special care has been taken to avoid the financial weaknesses which have been so clearly developed in the past few years in many of the older rapid transit systems.

CHAPTER I.

GENERAL BASIS OF REPORT.

The following are the fundamental facts upon which this report and the recommendations contained therein are based.

Population Growth of Detroit

The population of the City of Detroit and suburbs began a very rapid rate of increase about 1880. The following figures, compiled from the United States census, together with our own investigations and the compilations of local authorities, all as noted, illustrate the rapidity of this growth up to 1917. They form the basis for our estimate up to 1950, which estimate is discussed in detail in the "Financial Plan," page 58.

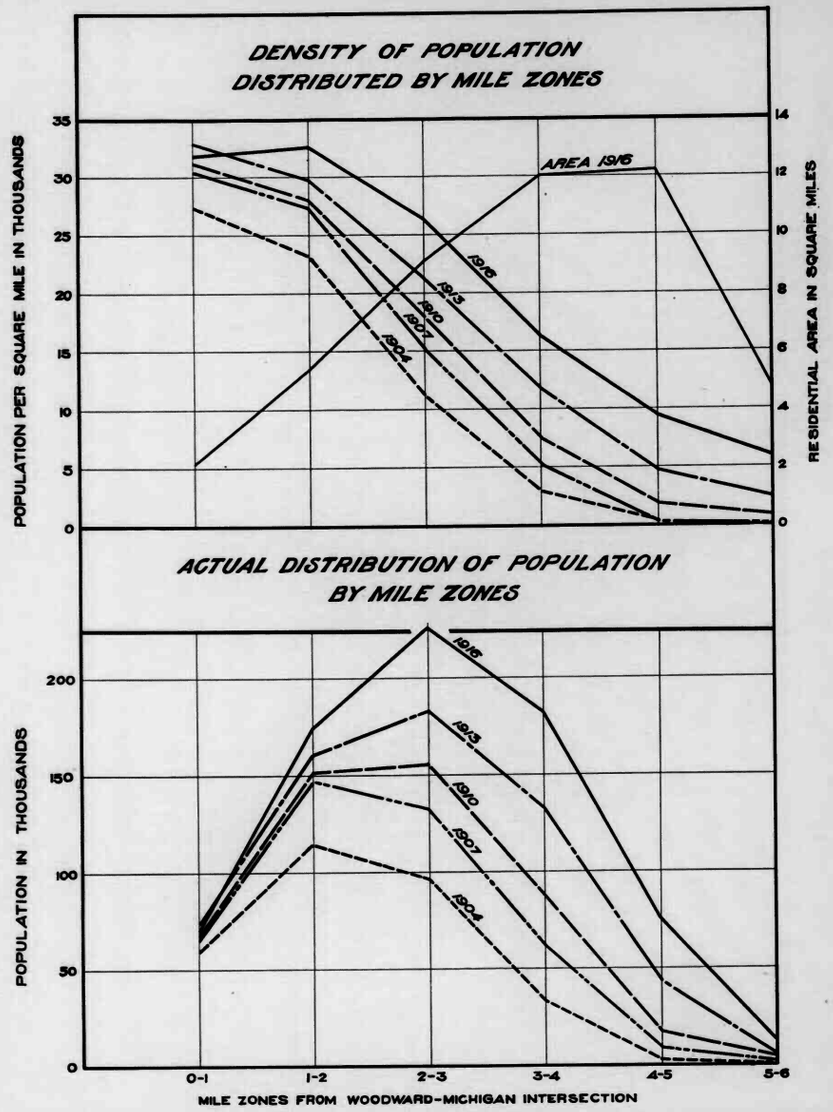
Population of Detroit and Suburbs

1880	140,000	(Estimate by B. P. & K.)
1890	234,000	(Estimate by B. P. & K.)
1900	318,967	(United States Census)
1910	500,982	(United States Census)
1913	614,486	(Estimate by City Directory)
1914	660,000	(Estimate by City Directory)
1916	820,000	(B. P. & K. Canvass)
1917	914,000	(Estimate by City Directory)
1920	1,000,000	(Estimate by B. P. & K.)
1930	1,333,000	(Estimate by B. P. & K.)
1940	1,666,000	(Estimate by B. P. & K.)
1950	2,000,000	(Estimate by B. P. & K.)

Density of Population and Outward Residential Movement

The general population movement of the City is outward from the center reckoned as the City Hall. On diagram, page 18, is shown the distribution of the residential population by mile zones, i. e., in the zone determined by a circle of one mile radius, in the zone between this and a circle of two mile radius, etc., the center of the circles being the intersection of Michigan and Woodward avenues.

On the upper diagram, the ordinates of the curves for different years show the number of people in thousands per square mile in the different zones, the area of which is represented by the curve marked "Area 1916." The horizontal scale shows the distances in miles of the same zones from City Hall.



Thus on the upper diagram the intersection of the curve 1916 with the vertical line 1—2 shows that in this year, on an average, 32,500 people per square mile were residing in the district or belt included between the one and two mile circles with the City Hall as a center. This was the zone of greatest density in 1916. In 1913 and preceding years the greatest density was, as the curves show, within the one mile circle.

The lower curve on this diagram shows that in 1916 the maximum number of people were resident in the zone or belt between two and three miles from the City Hall. It will be noted that in 1910 the number of residents in the 1—2 mile zone was about equal to the number in the 2—3 mile zone and previous to that date the inner 1—2 mile zone was the greatest in total population.

From both the diagrams it is readily seen that the heaviest growth in 1916 was in the 2—3 mile zone and the density of population, which prior to 1916 was greatest within a distance of one mile of the City Hall, is now at least a mile further out. This fact accounts to a great extent for the unprecedented growth of the street car traffic which occurred between the years 1913 and 1916.

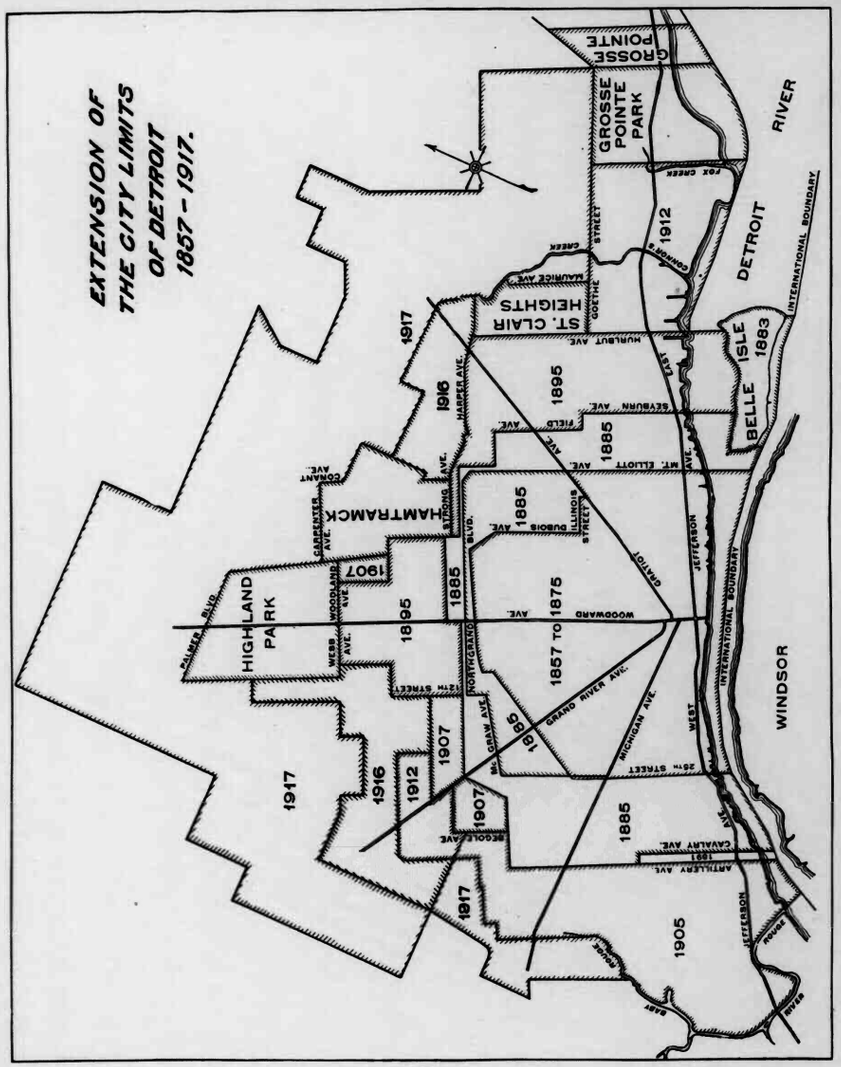
Area of Detroit

On page 20 is shown a map of the area of Detroit at different periods. The growth of the City area does not necessarily bear any relation to the growth of population, as the additions are usually made in convenient subdivisions for various reasons; but in general the City is seen to have spread outward quite uniformly, north, east, and west, the greatest extension having been toward the north. Woodward avenue throughout has remained very centrally located as the north and south axis of the City. The area of the City in 1900 was 28.34 square miles, in 1910 it was 40.79 square miles and in 1917 it grew to 80.67 square miles. Our estimate of the area necessary for the comfortable housing of a population of two million people is 155 square miles.

City's Size Justifies Rapid Transit

The necessity for rapid transit in a city does not necessarily commence coincident with any particular population. The density of population, residential location, and distance from points of occupation, as well as physical features of the City area may be controlling factors. It is interesting to note that Boston commenced its rapid transit program when its population reached approximately 830,000. The initial elevated railroad construction, the only form of rapid transit in Chicago, was commenced when the city was slightly over the 1,000,000 mark and Philadelphia's first rapid transit line was started when the city had approximately 1,400,000 population.

If dependence can be placed upon the indications of the past twenty years,



Detroit's future growth to a city of 1,500,000 or 2,000,000 people is perfectly reasonable to anticipate.

Detroit in the matter of size has therefore reached the stage where other cities entered upon their rapid transit development.

The transit facilities of a city are so intimately connected with its commercial success and steady development that it is hardly to be conceived that an active manufacturing city, like Detroit, could grow to anything like the 1,500,000 or 2,000,000 mark without necessarily and simultaneously developing a rapid transit system.

Built on a practically level plain, with no real physical obstructions to city extension, the inevitable character of Detroit's growth must be towards residence districts of relatively low population density, detached houses of the one and two-family type predominating. A population, therefore, of over 1,000,000 people distributed at about 20 per acre involves a city area of about 100 square miles and the necessity of regularly hauling many passengers eight to ten miles. With ordinary electric street car service, this means a ride of about one hour. This is the generally recognized limit within which daily trips must be kept to be satisfactory to those making habitual use of such a line. Detroit, if it has not already, will within the next few years reach just such conditions.

Traffic Growth

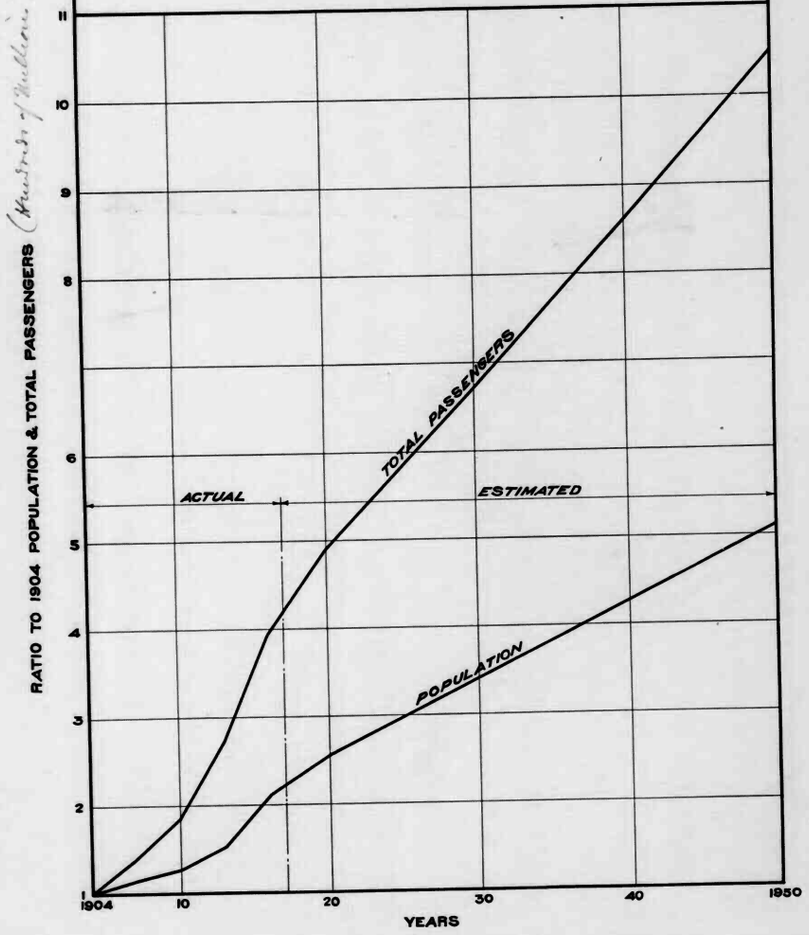
The traffic growth for the City lines is not obtainable in the early periods. The following table shows the actual and estimated passenger traffic since 1904, and diagram, page 22, indicates its rapid growth in proportion to the population increase.

Actual and Estimated Passenger Traffic

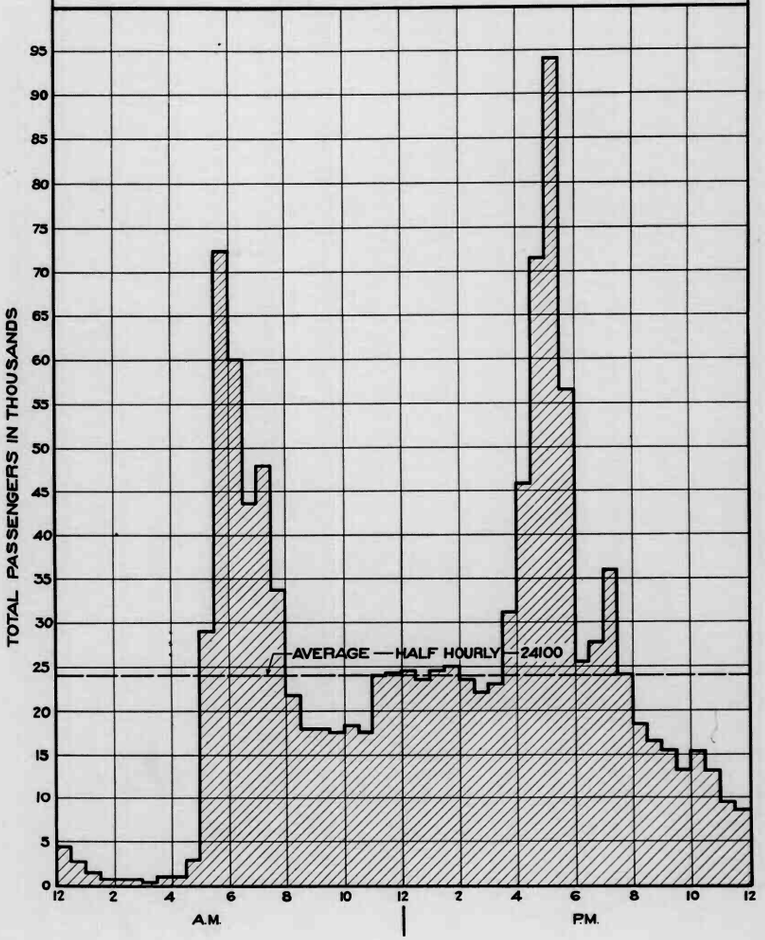
Year	Passengers		Revenue Rides per Capita	Increase Rides per Capita per Annum
	Total	Revenue		
1904	105,641,220	78,349,220	248	
1910	194,388,505	141,690,525	282	5.68
1913	289,130,216	208,945,348	339	19.00
1914	310,010,104	219,606,056	333	6.00*
1916	417,780,244	292,043,741	356	11.50
1917	440,544,836	315,498,478	361	5.00
1920	518,000,000	370,000,000	370	3.00
1930	708,000,000	507,000,000	380	1.00
1940	904,000,000	650,000,000	390	1.00
1950	1,110,000,000	800,000,000	400	1.00

*Decrease

RELATIVE GROWTH OF POPULATION AND TRAFFIC



HALF HOURLY PASSENGERS CARRIED IN 24 HOURS APRIL 1916



The rapid increase both in total traffic, revenue rides, and rides per capita is obvious so far as existing statistics are concerned, namely, to 1917. Beyond that point the prediction is based upon estimates as to the increase in riding habit experienced in other cities.

The unusually high revenue rides per capita of this City and the quite extraordinary increases of the past ten years warrant the prediction of some further growth. A maximum of 400 rides per capita per annum has been set as the limit for the riding habit, upon the theory that even in a manufacturing city of great industrial activity, 400 rides per annum per individual is as high an average as is reasonable to expect. The further increase from 361 rides per capita in 1917 is taken at 3 per annum for the next three years and one per annum from 1920 to 1950. This latter uniform rate of increase is arbitrarily assumed, and it is conservative in view of the average of 8.7 annual increase for the past 12 years and does not involve the detailed prediction of the fluctuations from year to year in this rate, in which accuracy would obviously be impossible.

Congestion on Surface Lines

Rapid transit in Boston was forced more by the intolerably congested condition of streets in the principal delivery district, than by reason of the length of haul. In Chicago, on the contrary, the length of haul was more particularly the controlling factor. In Detroit both these conditions are becoming acute. The surface car congestion in the center of the City during the rush hours, even as relieved by the re-routing arrangement recommended in our 1915 report, still presents serious difficulties. The traffic congestion on the main thoroughfares converging at practically one point must soon force some other form of transportation, at least in this central part of the City.

The extremely trying conditions of congestion during the rush hours, especially during the evening rush, are illustrated in diagram, page 23, in which the number of passengers carried by the street cars is shown by half hourly intervals. During 2½ hours each day twice the average number of passengers for 24 hours are carried. For one hour three times and for one-half hour four times the average number of passengers are carried. Thus 95,000 people must be accommodated during the maximum one-half hour or at a rate of 190,000 per hour against an average of 48,000 per hour for the whole day. A large proportion of these riders originate at or cross the business district and their number grows each year. The impossibility of providing adequate facilities for handling this traffic on the surface of the streets is becoming quite apparent.

The length of haul is also increasing with extensions of the city area, until a considerable part of the traffic on some lines is carried six to ten miles.

It must be remembered that passengers originating on one line in the outskirts of the City are frequently employed in factories on the other side of town and use two lines riding twelve to eighteen miles each way daily.

Besides the mere question of crossing interferences, the traffic on some of the lines in Detroit, notably Woodward avenue, has reached a density which is practically the limit of the carrying capacity of two surface car tracks on a single street. The heaviest of these lines deserve special analysis.

The recommendations for improving surface car conditions made in our 1915 report have in large measure been adopted and with beneficial results. As then pointed out, however:

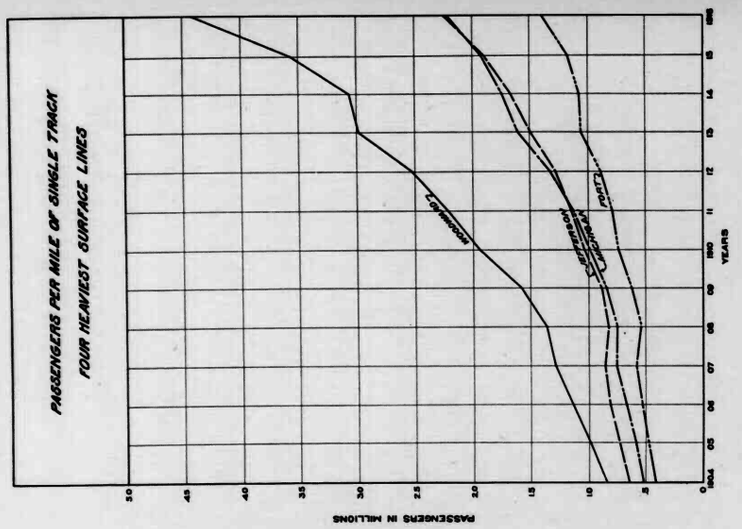
> "Provision must be made for handling in the future during rush hours not only a much greater volume of traffic than at present, but one of greater density than now occurs at the congested center.
>
> "The growth of the business district, together with the increased density of pedestrian, vehicle and street car movements will in time make demands beyond the possible limits of surface street car transportation.
>
> "Assuming that the growth of Detroit will continue to and beyond the 1,000,000 population mark and that its future importance as a great manufacturing center will be maintained, additional steps in the development of its transportation system should be prepared for, following and supplementing the re-routing and related recommendations just made."

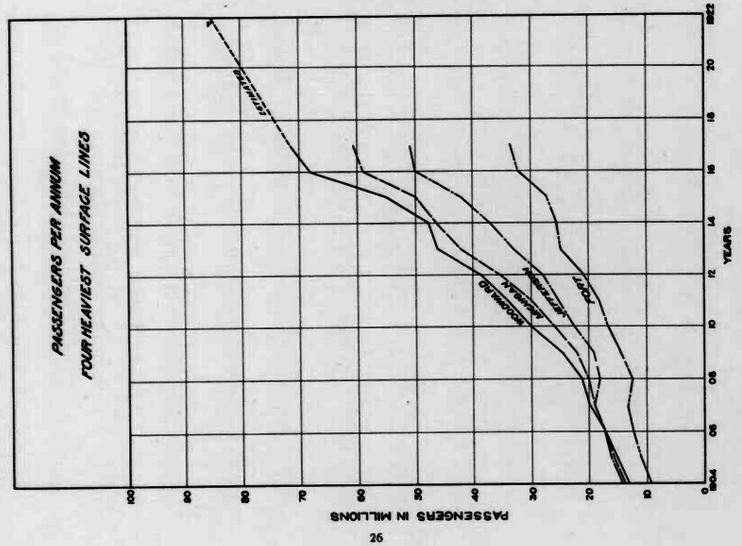
The fact is that exactly the conditions predicted in 1915 now exist, the time, however, has been shorter than was then anticipated. The introduction of two car units and skip stops has made possible the carrying of greater traffic on the heavier surface lines, but with the accompanying increase in pedestrian and vehicular interference, the limit of capacity with any reasonable speed of cars has been reached.

Traffic Growth 1914 to 1917

The estimates made in 1915 as to future growth of traffic and based on the traffic figures up to 1914 warranted the recommendation then made, that definite preparations should be undertaken for the building of an initial subway on Woodward avenue, should the growth of the City continue at recent rates. Doubt was expressed as to whether a surface car line could for many more years be able to handle satisfactorily the Woodward avenue traffic.

Since 1914 the traffic has increased even in excess of the most liberal estimates we then felt warranted in making. The traffic investigation conducted during the summer and fall of 1917 discloses the following greatly altered conditions on the heaviest lines of the City:





Total Passengers Per Annum Carried on the Four Heaviest Lines in Detroit

Line	1914	1917	Increase, per cent
Woodward	47,457,294	72,000,000	52.0
Michigan	46,484,661	61,000,000	31.0
Jefferson	37,036,773	51,000,000	37.0
Fort	25,316,295	33,000,000	31.4

It will be seen that Woodward avenue has not only continued to maintain its position as the heaviest traffic line but has also made the largest rate of increase. However, the foregoing figures greatly underestimate the importance of the Woodward avenue line for rapid transit due to the fact that the foregoing total figures do not show the density of travel.

The diagrams, page 26, show these conditions clearly. The left-hand diagram, indicating the total passengers per annum for the four heaviest surface lines, shows the growth of the total traffic for each of these lines to be at the same general rate. The right-hand diagram giving the passengers per mile of single track shows the greater density and the greater rate of increase of the Woodward avenue line over all others in the City. Stated in figures, this is as follows:

Total Passengers Per Mile Single Track Detroit—Chicago—New York

Line	1914	1917	Per cent Increase
Woodward	3,060,600	4,640,000	52.0
Michigan	1,737,900	2,280,000	31.1
Jefferson	1,716,500	2,290,000	33.4
Fort	1,074,000	1,400,000	30.3
Halstead street, Chicago	. . . .	3,230,000*	. .
Elevated Railways, Chicago	1,022,000	1,115,000*	9.2
Elevated Railways, Manhattan and Bronx, N. Y.	3,040,800	3,230,000	6.2
Elevated Railways, Brooklyn	. . . .	1,295,000	. .
Hudson and Manhattan Tubes N. Y.	3,447,200	3,673,000	6.6
Subway, New York	4,468,500	4,970,000*	11.3

*1916

The Woodward avenue line therefore carried in 1917 a denser traffic per mile of track than the heaviest rapid transit lines in this country with the single exception of the New York subway in 1916. With the added trackage of the year 1917, the New York subway figure is considerably lower than Woodward avenue in 1917.

Woodward avenue is also seen to have in 1917 more than twice the density of traffic of the Michigan avenue and also twice that of the Jefferson avenue line. The density of traffic on Woodward avenue is also 44 per cent heavier than Halstead street, the heaviest street car line in the city of Chicago, in fact as far as we are able to ascertain, there is no single line of surface cars at present operating over a distance of seven or eight miles that carries as heavy a traffic as this Detroit line. There are heavier lines for a few blocks in a number of cities, which, due to the convergence and uniting of several lines upon a single thoroughfare, carry the combined traffic of widely divergent routes, but Woodward avenue, on the contrary, is a line without converging branches. The entire traffic is hauled over two tracks, the passengers either originating along the line or reaching it by transfer from intersecting lines.

Transfer Traffic

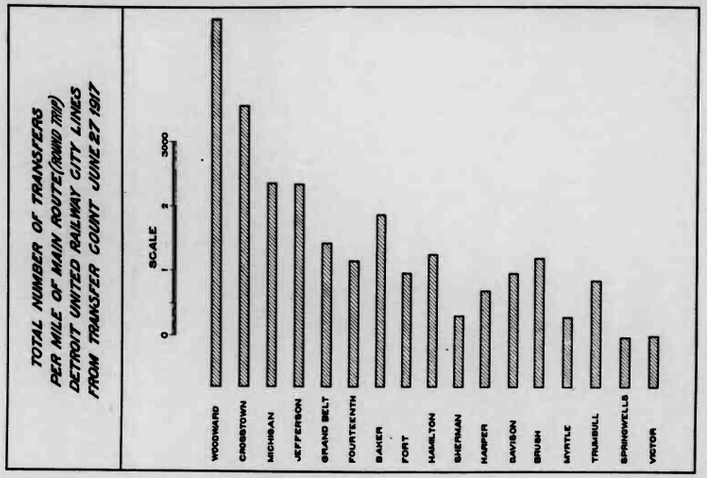
On account of the extensive transfer privileges available to passengers on the existing street railway system a knowledge of how these passengers now find it convenient to utilize these transfer facilities is important, as a transfer is contemplated between the surface and proposed rapid transit lines. It has been found in actual practice that where time can be saved a passenger will transfer from the surface to the rapid transit line and vice versa if the transfer arrangements are convenient.

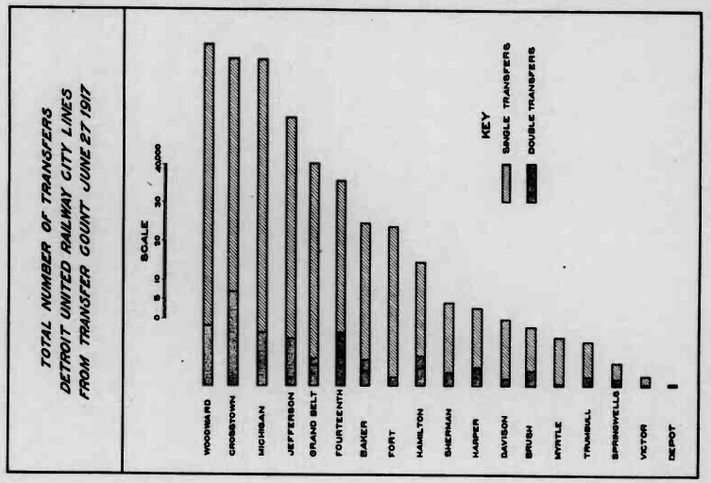
A transfer count was made on all the lines of the D. U. R. surface car system in the City of Detroit covering the twenty-four hour period of June 27, 1917. This showed that transfers were issued and used in a number equal to 39.1 per cent. of the revenue passengers. There were 864,303 revenue passengers who presented tickets or cash for their initial ride. Of these, 275,957 transferred to another line and 62,077 of these latter made a second transfer. This means that 338,034 transfer rides were made during the day by the 864,404 revenue passengers.

Record of Passengers, June 27, 1917
Revenue, Free and Transfer

Revenue passengers, 6 tickets for 25 cents	273
Revenue passengers, 7 tickets for 25 cents	743,660
Revenue passengers, 8 tickets for 25 cents	65,755
Revenue passengers, Interurban tickets	2,283
Revenue passengers, 5 cent tickets	877
Revenue passengers, 5 cent cash fare each	51,455
Free riders (employees)	22,720
Transfers, single	275,957
Transfers, double	62,077
Total	1,225,057

Of the total of 338,034 transfers made on the city system on the day of the check, 119,632, or 35.4 per cent occurred in the central district between





State street and the river and of these 57,817, or 48.3 per cent, were to or from the Woodward avenue line.

The largest number of transfer passengers were carried on the Woodward, Crosstown, Michigan and Jefferson lines. The Grand Belt and the Fourteenth lines, however, did a very heavy transfer business. Woodward avenue with the largest number of total passengers for any line in the City also had the largest number of transfer passengers. Of the total traffic handled on this line 46.6 per cent transferred either to or from the line on the day of this check which is the same percentage as the average percentage for this line for the year 1916. The Crosstown line, carrying the second largest number of transfer passengers, showed that 85 per cent of its total passengers transferred to or from this line. In other words, out of a total of 98,269 total crosstown passengers carried, 84,988 used transfers. The Michigan avenue line carrying the third largest transfer business gave to or received transfers from 51 per cent of its total passengers.

The diagrams, page 29, show graphically the relative number of transfer passengers carried on each line in the City and the number of transfer passengers per mile of single track. Consideration of the lines susceptible of development into rapid transit routes is all that is here necessary. The following shows the transfer characteristics of these lines:

Transfer Passengers, Twenty-four Hour Check, on Four Heaviest Lines

Line	Total Transfers	Transfers per Mile of Single Track
Woodward	88,495	5700
Michigan	84,511	3150
Jefferson	69,575	3130
Fort	41,278	1760

In transfer passengers Woodward avenue is again seen to have the greatest number of any line in the City and also the greatest number per mile of single track. This line also receives transfer passengers in considerable numbers from more lines than any other single line in the City. This shows that the Woodward avenue line serves the whole City area more nearly than any other. Of the 189,736 daily passengers riding on Woodward avenue cars 46.6 per cent. transfer either to or from other lines and of these 18 per cent., or 15,547 passengers, make a second transfer to reach remote parts of the City. Following the individual groups it was found that practically all residence districts of the City contribute their quota to this line. A rapid transit line on this main thoroughfare will be giving half of its service to passengers not resident on this line.

The distribution of the transfer traffic along Woodward avenue is also

important. Of the total of 88,495 transfer passengers to or from Woodward avenue 57,817, or 65.3 per cent, are handled between State street and Jefferson avenue or what may be termed the central district of the City. The next largest transfer is at the Crosstown line, where 16,538, or 18.7 per cent, were handled, while the Grand Belt line handles 11,133 or 12.6 per cent, and the Victor Junction line 3,007, or 3.4 per cent. The predominating importance of the transfer at the center of the City is therefore obvious. On the other hand it is found that the three transfer lines, the Crosstown, Grand Belt and Victor handled 20,859 passengers, or 67.8 per cent, of their total Woodward transfers to or from points north on Woodward avenue. The full details of this transfer count are included in Appendix I and are shown graphically in diagrams, pages, 100, 101 and 102.

Estimated Rapid Transit Traffic

Considering the growth of the past ten years it is reasonable to estimate a passenger traffic on the Woodward avenue line by the year 1922 of 85,000,000 total passengers. This estimate is based upon the assumption of free transfers between this line and the intersecting car lines and the building of a rapid transit line along this street to be in operation at about this date. Based upon estimates of time saving through the use of the rapid transit line by the long haul riders, it is quite probable that 50,000,000 of the total passengers would use the rapid transit trains if the same fare and free transfer were offered. Such a division of the total traffic will at once relieve the overcrowded condition of the surface lines and make possible improvement in both running time and service.

An analysis of the 1916 traffic of five of the heaviest lines in the City of Detroit has been made to find the proportion of their traffic tributary to a rapid transit line similarly located. The figures shown in the following table are somewhat low due to the omission of any allowance for the diversion of traffic from parallel lines, which traffic would be attracted by the higher speed of the adjacent rapid transit line. This item has been omitted due to the great difficulty of predicting its volume and it is noted here as an added safety factor.

By assuming, in estimates of future traffic, that the rapid transit passengers will bear the same proportion to the total passengers as is shown in the foregoing division of existing traffic on the surface lines, a very conservative position is taken. The fact is that during the period of construction of the rapid transit lines, a considerable increase in long haul riders will be experienced in anticipation of the higher speed service.

Estimated Division of Traffic for 1916 Between Surface and Rapid Transit Lines

Name of Line	Total Passengers on Present Car Line	No. of Passengers Tributary to Rapid Transit	Per cent	Average Haul (Miles)	
				Present Lines	Rapid Transit
Woodward	68,063,539	31,720,000	46.7	2.81	3.85
Michigan-Gratiot	59,261,452	29,506,000	49.6	3.11	4.22
Jefferson-Grand River	51,237,265	26,322,000	51.2	3.26	4.50
Fort	32,756,003	15,504,000	47.5	2.81	3.72
Crosstown	41,477,381	14,250,000	34.4	2.05	3.30

The origin and destination of the passengers was determined on basis of the 1914 traffic count. The per cent of total passengers tributary to the rapid transit line was determined by the method of time saving, the speed of the street cars and rapid transit being taken at nine miles and sixteen miles per hour respectively.

It is seen from the foregoing tabulation, that while the total number of passengers on Woodward avenue is in excess of the other lines, the length of haul is not so great. The principal deciding factors in favor of Woodward avenue as the initial rapid transit line is the density of traffic, the impossibility of adequate service on the existing street car system and the continued increasing rate of growth on this line.

In the financial plan it has been necessary to assume some order in which the subsequent lines are to be built. After the initial step the program has been arranged in such a manner as to allow the changing of this order if necessary. The sequence in order of construction is based upon the general assumption, that the city will continue to grow in such a manner that the present proportion of the traffic on the various transit lines will be maintained.

Following this line of reasoning and referring to the table, the Michigan-Gratiot rapid transit line was selected as the second step in the program. In this connection it is pointed out that the tracks of the Michigan-Gratiot surface line also carry a number of other car lines. This traffic, which does not appear in the foregoing table, is considerable and is hauled for a distance of several miles on Michigan and Gratiot avenues, thereby increasing the importance of this route.

A glance at the diagram on page 48 shows that these two first lines, Woodward and Michigan-Gratiot, form rapid transit arteries at right angles to one another, one north and south along the central axis of the City (Woodward avenue), the other east and west over the next heaviest traffic line and traversing the most heavily settled residential districts.

A further discussion of this subject is given in Chapter II.

Public Demand for Service

It is of course impossible to say what number of passengers a certain car line can carry. That is largely a function of the quality of service which the operating company can provide at the prevailing fare, and of how much inconvenience the passengers will stand in crowding and low speed. It also depends upon the physical limitations of the traffic, such as vehicle and pedestrian interference, frequency of stops, etc.

For similar reasons, the carrying capacity of rapid transit lines cannot be accurately determined. In New York the Interboro Subway was designed for and expected to carry 400,000 passengers per day, but by 1912 it was carrying 830,000 daily, and the condition of crowding during rush hours was then considered intolerable. This condition existed notwithstanding the lengthening of trains and platforms and the reduction of the headway, until it was impracticable to give more accommodation. In 1917 the average daily traffic amounted to 1,130,000 passengers with a corresponding increase in congestion, directly due to the long delay in providing for additional rapid transit lines.

The history of rapid transit construction in large cities in recent years has been a succession of postponements and delays in deciding upon a plan and actually starting construction work. The public have usually failed to realize the long period required to plan and build modern subway lines and as a result years of discomfort and inadequate service have been endured, which might have been avoided, had a more far sighted course been pursued.

In order to use to advantage the experience gained in other cities an immediate decision of entering upon the rapid transit policy in Detroit should be made. The initial plan should be based on the needs of a population of from 1,300,000 to 1,500,000 to which the city is expected to grow within the next 15 years. Conversely upon the decision to build or not to build, this increase will partly depend. It is a well recognized fact that transit facilities, even in the building period, stimulate growth in anticipation of the service to be later supplied.

It must be kept in mind, that were the plans herein proposed approved by the Commissioners and submitted to referendum vote in April, 1918, and then favorably acted upon, the preparation of plans, letting of contracts and actual construction of a subway on Woodward avenue would not give actual service before the autumn of 1921 or early in 1922, and other lines at an even later date.

It is not intended here to urge the commencement of actual construction of subways in Detroit at such a time as the present, when all financial and construction resources are under the strain of a great war. It is intended, however, to point out that a considerable number of years must necessarily

elapse between a decision to build and the commencement of successful operation, and that of this period much of the time must be employed in the working out of the details of agreements, specifications and plans, which would not involve expenditures of large amounts of money and which, when completed, would make immediate construction possible upon the resumption of normal conditions.

In order to discuss the situation in a clear and understandable manner it has been necessary to assume a definite program for the construction of successive rapid transit lines, keeping step with the requirements of the estimated growth in population, thus fixing for these periods specific costs of construction and operation. By assuming the earliest possible dates, regardless of war conditions, it is thought that if a favorable transportation and a feasible financial plan can be developed, postponement to any later date will only tend to increase both the necessity for the transit facilities and the assurance of sufficient earnings to support them.

Summary of Physical Conditions

To summarize the foregoing discussion of the physical requirements of the City it may be said that:

(a) Detroit's growth in population and area has now continued for such a period of years and through so many changes in commercial, political and economic conditions, that its continued future development to a city of one and one-half to two million population is a reasonable prediction. The natural fears of some at the time of our previous study of the situation, (1914), that the city was experiencing an unhealthy boom due to temporary prosperity in the automobile business of the country, seem fully disproved by the subsequent developments.

The present decrease in the D. U. R. passenger earnings are indicative of the period of re-adjustment, through which Detroit's manufacturing plants are passing due to present war conditions. This decrease appears to be temporary and while it may be accompanied by a slowing up in population growth or even actual loss, the resumption of growth at a rate, such as herein shown, is, we believe, to be confidently expected due to the financial strength and diversity of the City's industries.

(b) The density of traffic on its heaviest surface car lines is in excess, notably on Woodward avenue, of corresponding conditions in other cities where rapid transit has been considered a necessary and legitimate enterprise.

(c) The congestion of surface car traffic at the center of the City even as relieved by rerouting is only temporarily reduced, and any such growth of the City, as now seems certain, will in a few years cause a recurrence of really bad conditions.

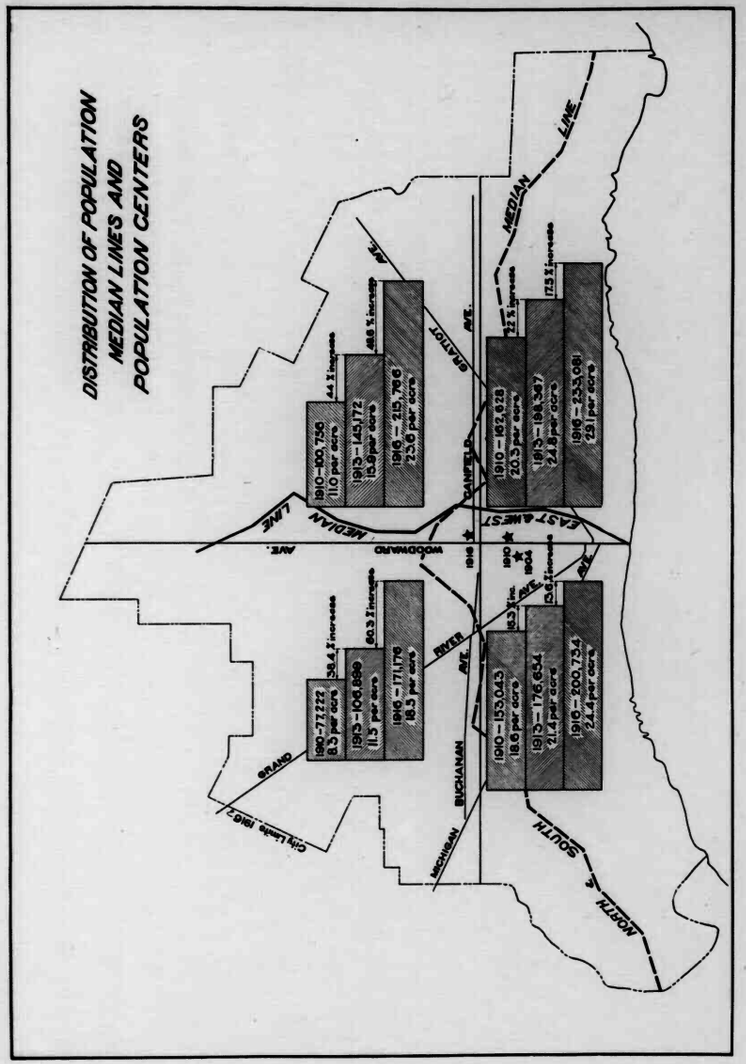
(d) The maximum capacity of the Woodward avenue surface line is practically reached unless slower speed and further crowding is considered acceptable to the public. Similar conditions are developing on other lines.

(e) The use of additional parallel street car lines on streets adjacent to Woodward avenue or other lines are of doubtful advantage on account of the dense automobile traffic on these thoroughfares, and the repeated experience in Detroit and other cities of the persistent tendency of passenger traffic to cling to the main business streets and not to utilize added service on parallel lines. Even if such lines were built and patronized, it is physically impossible to carry them to the general delivery district on account of the peculiar location of the streets in this area.

(f) All the traffic and physical conditions point to the reasonableness of developing a definite plan for rapid transit at this time. The traffic characteristics as to distribution of passengers, their districts of origin and destination have developed quite clearly, particularly in the past four or five years, so that the rapid transit needs of the immediate future at least can be seen.

The question of how soon construction should be commenced is not susceptible of demonstration as an engineering problem. It is purely a matter of public policy. We can only analyze the facts as we have found them, and point out the conditions as we see them and recommend means of relief for present needs and proper provisions for future requirements.

It is within the province of this Report and our experience to point out clearly the financial difficulties involved in building a modern rapid transit system in a large city and the cost of supporting the service. For this reason the following discussion of the proposed physical or construction program is followed by a chapter on the financial plan.



CHAPTER II

RAPID TRANSIT PLAN AND CONSTRUCTION PROGRAM

The rapid transit requirements of Detroit, based upon general considerations, have been discussed already. In the analysis of the present traffic conditions, the influence of the density of traffic, length of haul and volume of transfer, have been pointed out as important among the deciding factors in selecting the most desirable routes. In the following discussion the location of the most necessary high speed routes will be approached from different view points, i. e., from the angle of the present and future distribution of the population, and from the origin and destination of the riding public.

Residential Distribution of Population by Four Equal City Areas

The diagram on page 36 shows the distribution of population in the City in four divisions of nearly equal area, formed by Woodward avenue as the north and south dividing line, and by Buchanan and Canfield avenue as the east and west dividing line. The shaded rectangles indicate the population in these four divisions of the City, also the density and increase of the population for the years 1910, 1913, 1916. The remarkable uniformity in the increase east and west of Woodward avenue from 1910 to 1916 and the relatively uniform distribution of the population on either side of this axis is noteworthy.

Here then is clearly shown the residential location in four divisions of the total population of Detroit. This means the general location in four broad divisions of the origin and destination, morning and evening, of the City's daily riders.

Map 1 showing the population of Detroit by one-half mile squares for the years 1904, 1907, 1910, 1913 and 1916 indicates that in the past three years the heaviest growth has occurred in the northwest part of the City along Grand River and Michigan avenues and in the northeast part of the City, in and near Ste. Claire Heights. By taking, however, the period from 1910 to 1916 and combining the increases it is found that a remarkably uniform rate of increase has occurred over the entire City. These increases are grouped very uniformly east and west of Woodward avenue and north and south of the axis of Canfield avenue, as shown on the previously mentioned diagram.

The foregoing map also shows that there are an average of over 28,000 people per mile of line resident in a district extending one-half mile on either side of Woodward avenue for the first four miles north of Grand Circus. Similar districts adjacent to Gratiot avenue, show an average of 25,000 peo-

ple per mile of line; along Michigan avenue, 20,000; Fort street, 16,000, and Jefferson avenue, 11,000 people. While it is true that dense residential districts do not always produce a proportionate number of passengers, nevertheless, the foregoing relative figures indicate clearly the importance of Woodward avenue and the east and west rapid transit line paralleling Michigan and Gratiot avenues.

Employment Distribution in Detroit

The other termini of the daily trips of rush hour passengers may be seen in general on diagram page 39, showing the location of places of employment, factory and business, throughout the City. The circles placed at different points on this diagram indicate by their area the relative number of employees in each of these establishments during the summer of 1917. A tabulation of the larger factories in Detroit, their location and the number of employees is given in Appendix VII, for the years 1914 and 1916. The distribution of these employees, as indicated in our previous report, is very diversified for the individual factories. Nearly all the large factories draw their employees from all parts of the City. A recanvass of some of the principal factories in 1917 compared with our 1914 canvass indicates, as would be expected, the location of a somewhat larger proportion of such employees within walking distance of the factories. The same wide scattering of these factory workers into the various resident districts is still the predominant condition.

In addition to these facts there must be considered the known plans for developing employment districts by the location of large factory centres. In this class must be included the tractor factory of the Ford Company to be built at Baby Creek and River Rouge on the westerly outskirts of the City. The building of the Pennsylvania Railroad into this western part of the City will also undoubtedly be a factor in building up residential and business districts.

At the present time the factory locations are grouped principally along the Grand Trunk, Michigan Central and the Detroit Grand Haven Railroad lines and the river front, the principal increases noted since the 1914 investigation having been along the railroads rather than along the river. The residential population along the river also has shown a decrease, the general tendency being for both population and factory centres to move westward and northward.

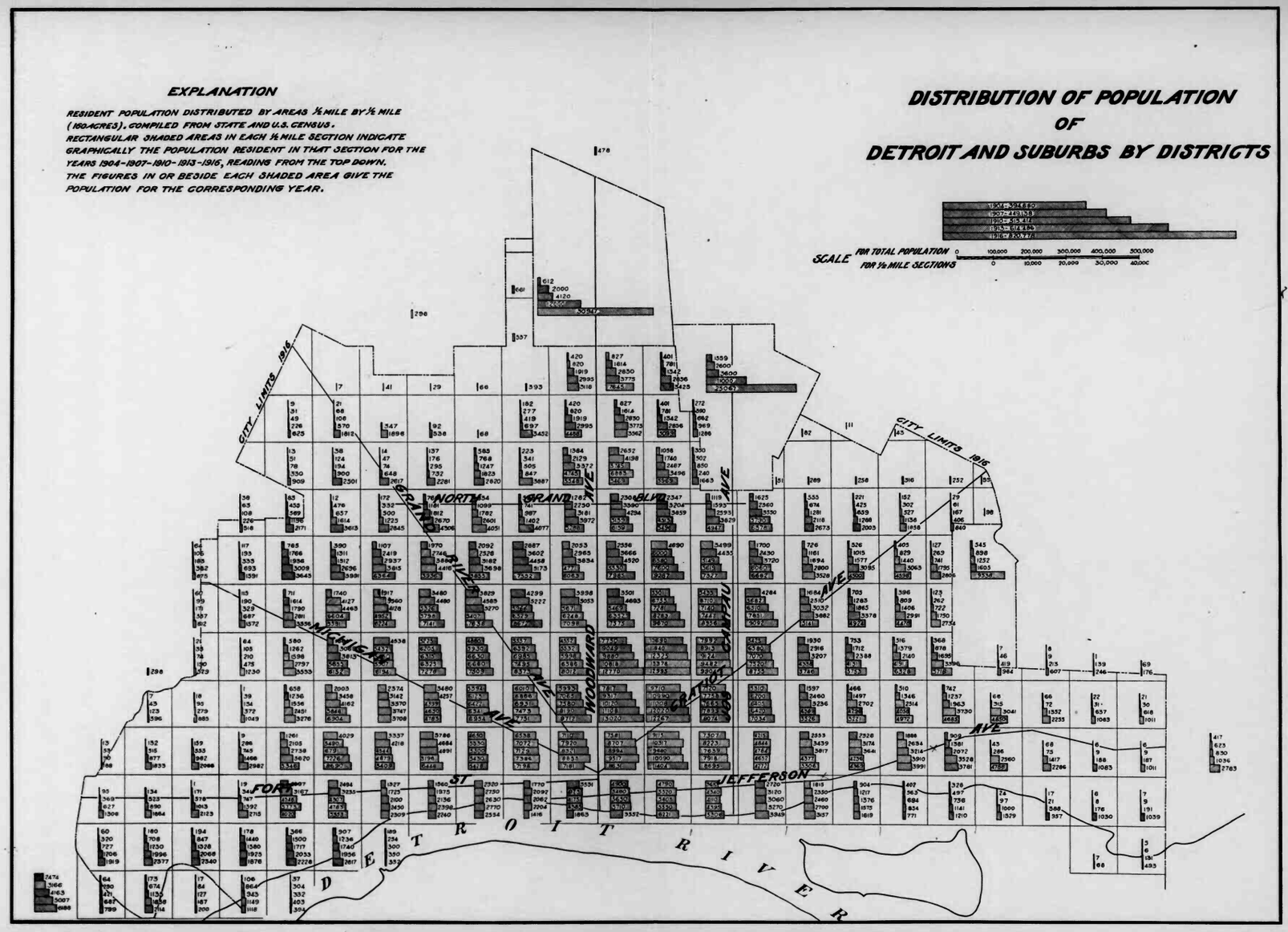
Building Activity Shown by City Permits

An examination of the building permits for the years 1914, 1915 and 1916 has been made and charted on map 2. From this the previously noted

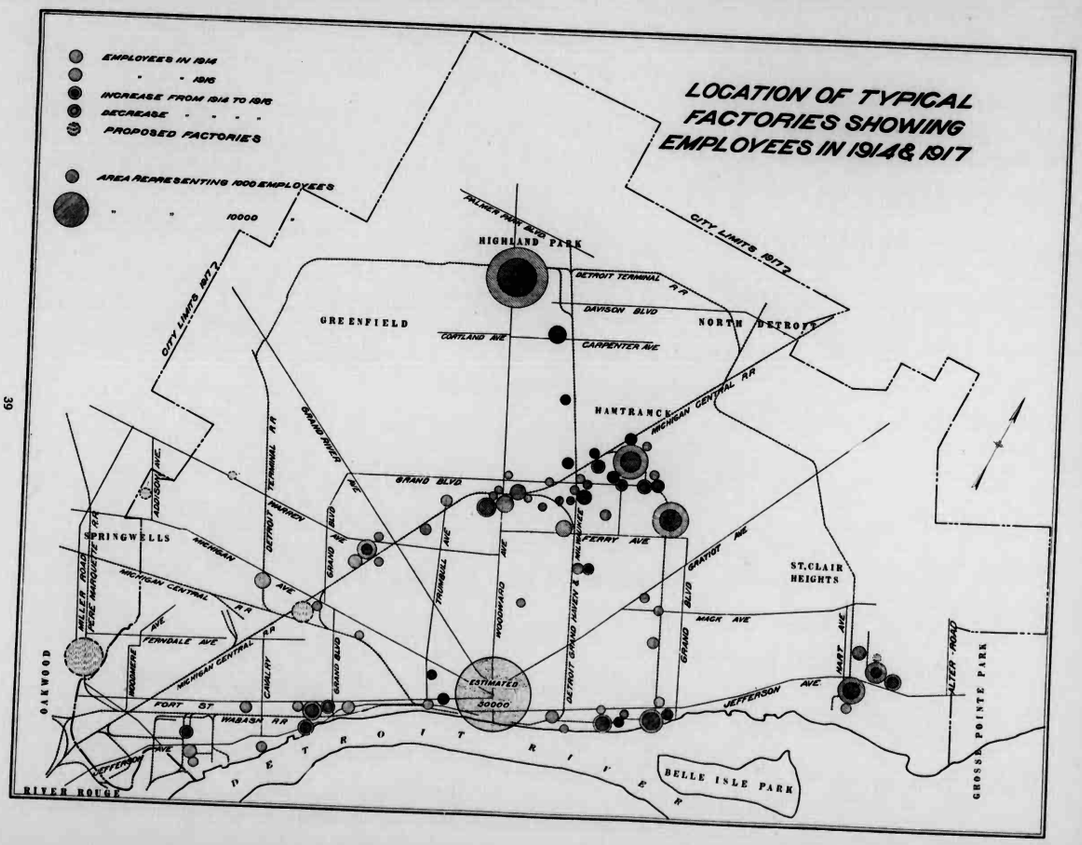
EXPLANATION

RESIDENT POPULATION DISTRIBUTED BY AREAS ½ MILE BY ½ MILE (160 ACRES). COMPILED FROM STATE AND U.S. CENSUS. RECTANGULAR SHADED AREAS IN EACH ½ MILE SECTION INDICATE GRAPHICALLY THE POPULATION RESIDENT IN THAT SECTION FOR THE YEARS 1904-1907-1910-1913-1916, READING FROM THE TOP DOWN. THE FIGURES IN OR BESIDE EACH SHADED AREA GIVE THE POPULATION FOR THE CORRESPONDING YEAR.

DISTRIBUTION OF POPULATION OF DETROIT AND SUBURBS BY DISTRICTS


1904-1907-1910-1913-1916
SCALE FOR TOTAL POPULATION 0 100,000 200,000 300,000 400,000 500,000
FOR ½ MILE SECTIONS 0 10,000 20,000 30,000 40,000
CITY LIMITS 1916
CITY LIMITS 1916
GRAND RIVER AVE
NORTH GRAND BLVD
WOODWARD AVE
MICHIGAN AVE
FORT ST
JEFFERSON AVE
D E T R O I T R I V E R

MAP 1


LOCATION OF TYPICAL FACTORIES SHOWING EMPLOYEES IN 1914 & 1917
EMPLOYEES IN 1914
" " 1917
INCREASE FROM 1914 TO 1917
DECREASE
PROPOSED FACTORIES
AREA REPRESENTING 1000 EMPLOYEES
" " 10000
CITY LIMITS 1917
CITY LIMITS 1877
HIGHLAND PARK
DETROIT TERMINAL R.R.
DAVISON BLVD
GREENFIELD
NORTH DETROIT
CORTLAND AVE.
CARPENTER AVE.
HAMTRAMCK
MICHIGAN CENTRAL R.R.
GRAND RIVER AVE.
GRAND BLVD
SPRINGWELLS
MICHIGAN
MILLER ROAD
PERE MARQUETTE R.R.
ADDISON AVE.
WARREN
TRUMBULL AVE.
WOODWARD AVE.
DETROIT GRAND HAVEN & MILWAUKEE R.R.
FERRY AVE.
GRATIOT AVE.
ST. CLAIR HEIGHTS
MACK AVE.
MICHIGAN CENTRAL R.R.
FERNDALE AVE.
HOOVER AVE.
CAMPBELL
GRAND BLVD
HART AVE.
ESTIMATED 30000
FORT ST.
WABASH R.R.
JEFFERSON AVE.
ALTER ROAD
OAKWOOD
JEFFERSON AVE.
DETROIT RIVER
BELLE ISLE PARK
GROSSE POINTE PARK
RIVER ROUGE

increase in the population of the northwestern part of the City is very apparent; also the increase in population in the northeasterly part of the City just west of Ste. Claire Heights.

Median Lines of Population

On diagram, page 36, the east and west median line has been drawn in solid black. This line indicates that east and west of any point in this line, the same number of people are resident within the City limits. The very close approximation of this line to Woodward avenue is obvious. Another line marked "north and south median line" divides the population north and south of this line into equal parts and crosses Woodward avenue between Ferry and Frederick avenues, about two and one-half miles north of the City Hall.

A judicious interpretation of the above facts can be utilized in deciding upon future rapid transit lines for the enlarged city.

Woodward Avenue, the Initial Rapid Transit Line

In our 1914-1915 report, Woodward avenue was pointed out as the most logical and promising location for a rapid transit line in Detroit. In all the traffic characteristics in which it was then apparent, that the Woodward avenue line exceeded others in the City, it has since increased in greater proportion than any other line.

The rapid change of Woodward avenue from a residential to a business street throughout most of its length has been increasingly apparent. This undoubtedly has been a material factor in attracting a disproportionate amount of the traffic increase of the City.

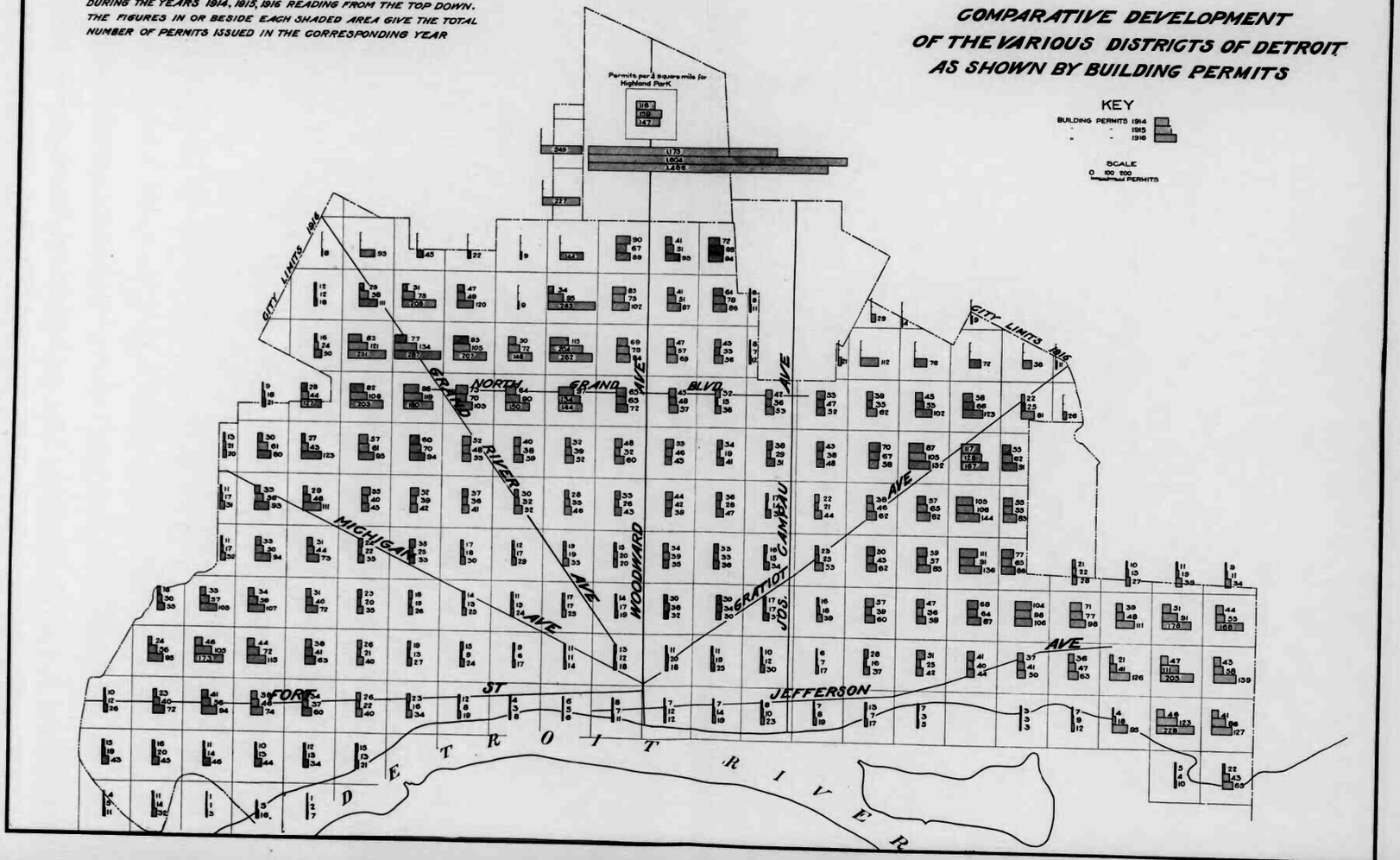
Taking into consideration the characteristics of the traffic growth previously discussed, the increases in and location of residential districts, as just mentioned, and the trend of factory location, it is seen that Woodward avenue is the heaviest trafficked, the most centrally located and the most rapidly growing thoroughfare in the City. Along its entire length it is becoming more and more a delivery district for passengers on the street itself, and the territory on either side is steadily increasing in population density. In all of these characteristics the increases taken as a whole are greater than on any other line.

Referring to diagram, page 36, it will be seen that the east and west median line nearly coincides with Woodward avenue, thereby indicating its importance due to central location and as an originating line, while on the other hand, it leads through and directly into the most important business centre of the City. This unique location is one of the strongest features, favoring Woodward avenue as the most desirable location for an early high speed line.

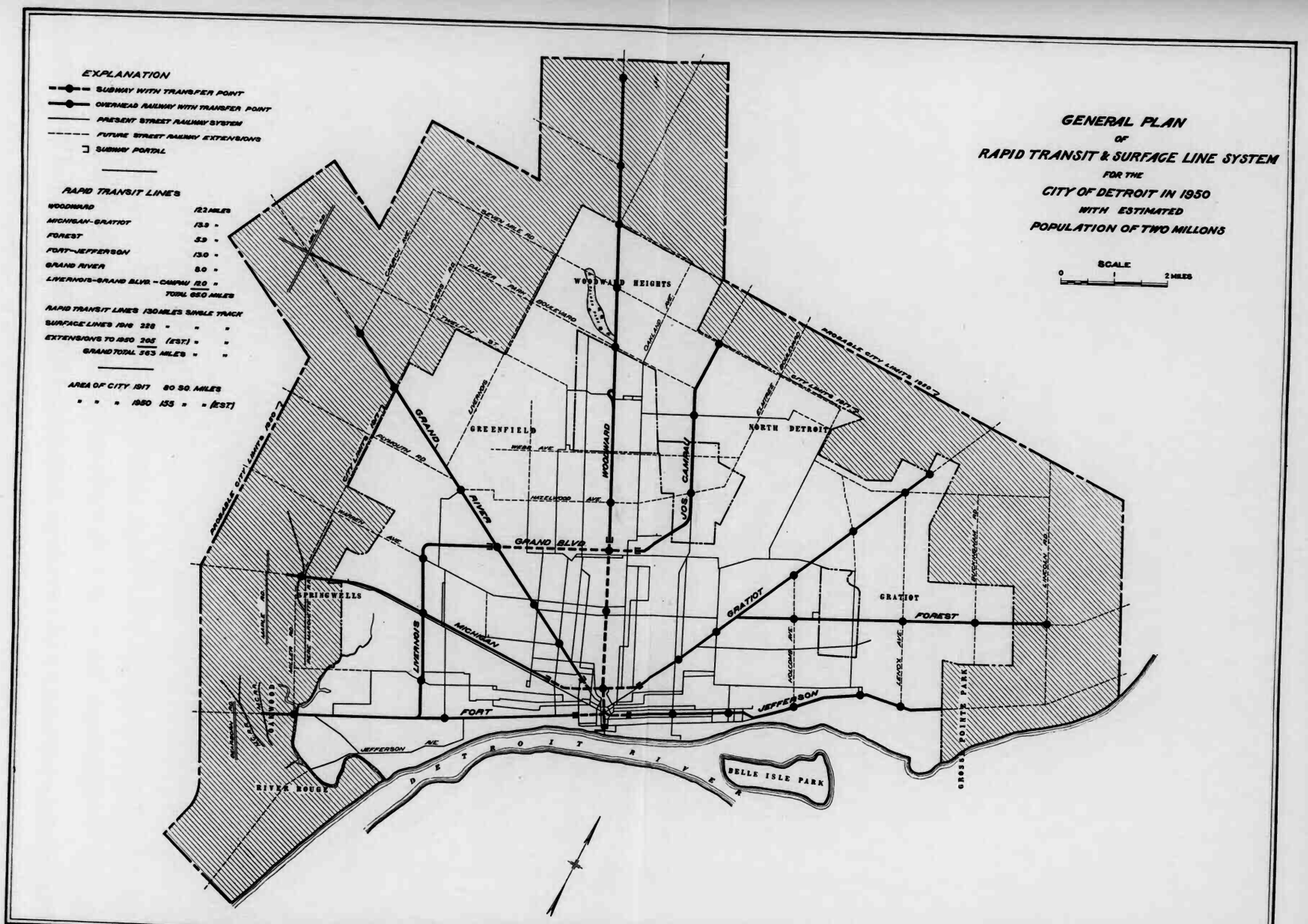
EXPLANATION

THE RECTANGULAR SHADED AREAS IN EACH ¼ SQUARE MILE SECTION INDICATE BY THEIR LENGTH THE NUMBER OF PERMITS FOR ALL CLASSES OF BUILDINGS ISSUED FOR THAT SECTION DURING THE YEARS 1914, 1915, 1916 READING FROM THE TOP DOWN. THE FIGURES IN OR BESIDE EACH SHADED AREA GIVE THE TOTAL NUMBER OF PERMITS ISSUED IN THE CORRESPONDING YEAR

COMPARATIVE DEVELOPMENT OF THE VARIOUS DISTRICTS OF DETROIT AS SHOWN BY BUILDING PERMITS



MAP 2


EXPLANATION
SUBWAY WITH TRANSFER POINT
OVERHEAD RAILWAY WITH TRANSFER POINT
PRESENT STREET RAILWAY SYSTEM
FUTURE STREET RAILWAY EXTENSIONS
SUBWAY PORTAL
RAPID TRANSIT LINES
WOODWARD 12.2 MILES
MICHIGAN-GRATIOT 13.9 "
FOREST 5.9 "
FORT-JEFFERSON 13.0 "
GRAND RIVER 8.0 "
LIVERNOIS-GRAND BLVD.-CAMPAU 12.0 "
TOTAL 65.0 MILES
RAPID TRANSIT LINES 130 MILES SINGLE TRACK
SURFACE LINES 1916 228 " " "
EXTENSIONS TO 1950 205 (EST.) " "
GRAND TOTAL 363 MILES " "
AREA OF CITY 1917 80 SQ. MILES
" " " 1950 155 " " (EST.)
GENERAL PLAN
OF
RAPID TRANSIT & SURFACE LINE SYSTEM
FOR THE
CITY OF DETROIT IN 1950
WITH ESTIMATED
POPULATION OF TWO MILLONS
SCALE
0 1 2 MILES
PROBABLE CITY LIMITS 1950
WOODWARD HEIGHTS
GREENFIELD
NORTH DETROIT
SPRINGWELLS
GRATIOT
RIVER ROUGE
BELLE ISLE PARK
GRAND RIVER
WOODWARD
GRATIOT
FOREST
MICHIGAN
LIVERNOIS
FORT
JEFFERSON
GRAND BLVD.
JOS. CAMPAU
DETROIT RIVER
GROSSE POINTE PARK

MAP 3

This line has, therefore, been selected in the following plan as the initial rapid transit line of the City, to be followed by an east and west line, which should intersect it at or near the centre of the central delivery district. This district is still located along Woodward avenue and the immediately adjacent streets, and extends from the Grand Circus to the river.

Other Rapid Transit Lines

On map 3 a possible complete rapid transit system is shown for supplying the needs of the City of Detroit, when it reaches about 2,000,000 population. On this map showing the existing outlines of the City, has been added an extension of the City area sufficient to allow of an increase in the population to 2,000,000 people without increasing the average population density per acre above twenty people.

In order that a rapid transit system for the City shall serve the long haul passengers and, at the same time, relieve surface car congestion, the prospective lines should be laid out in general so as to serve the main residential districts and connect them with the delivery districts by the shortest routes.

In the case of a long narrow city such as New York, when it was confined to Manhattan Island, the traffic and particularly the long distance riders used almost exclusively the lines extending north and south, the long axis of the city. When, however, the problem of a radial city, such as Detroit, is approached, the conditions are found to be quite different. The traffic here is destined to either a ring of outlying factories or to the center of the radiating system of streets, where is located the general business and retail district.

Having selected Woodward avenue as the initial rapid transit line of the City, and thus having provided for rapid transit north and south along the longest and heaviest existing line, the next step would obviously be a line through the principal delivery district at right angles to the above line and traversing the territory most in need of rapid transit service. A line laid out directly along or near the north and south median line, diagram, page 36, would obviously not render such service to the public, as will the Woodward avenue route, for the reason that while centrally located it would not lead into the delivery district except by transfer or detour. The selection of a crosstown rapid transit line is, therefore, here governed more largely by the indications of existing and probable future traffic conditions than by residential density.

On map 3 there are shown two principal east and west routes, one in general parallel with Jefferson avenue on the east, and Fort street on the west. North of this and crossing Woodward avenue at the Grand Circus another east and west route is shown paralleling Michigan, Gratiot and Forest avenues and extending from Springwells to east of Ste. Claire Heights.

Another line parallel with Grand River avenue is indicated joining the Michigan avenue line near the Grand Circus.

Another route is shown passing through Hamtramck near or upon Jos. Campau avenue to the Michigan Central tracks, thence parallel with these tracks and turning west under the Grand Boulevard to Livernois and south to Fort street.

It is, of course, obvious that the building of all of these lines immediately would be financially ruinous to whoever undertook to supply the money for financing such a project. The construction must, therefore, be contemplated in successive steps and of these Woodward avenue is the first, to be followed by an east and west line parallel with Michigan avenue and Gratiot avenue, as above described. The third step, present indications would suggest, would be a line located along or near Jefferson avenue. This line has many claims to preference in the way of a great proportion of long distance riders from the outlying districts, i. e., east of Belle Isle Bridge as far as Grosse Pointe. The westerly end of this line, if extended beyond Woodward avenue along Fort street, does not at present make a good showing. This might, however, prove the best method of reaching the district that will undoubtedly grow up along the River Rouge in connection with the Ford tractor plant. This same district might, on the other hand, be reached from the Michigan avenue line.

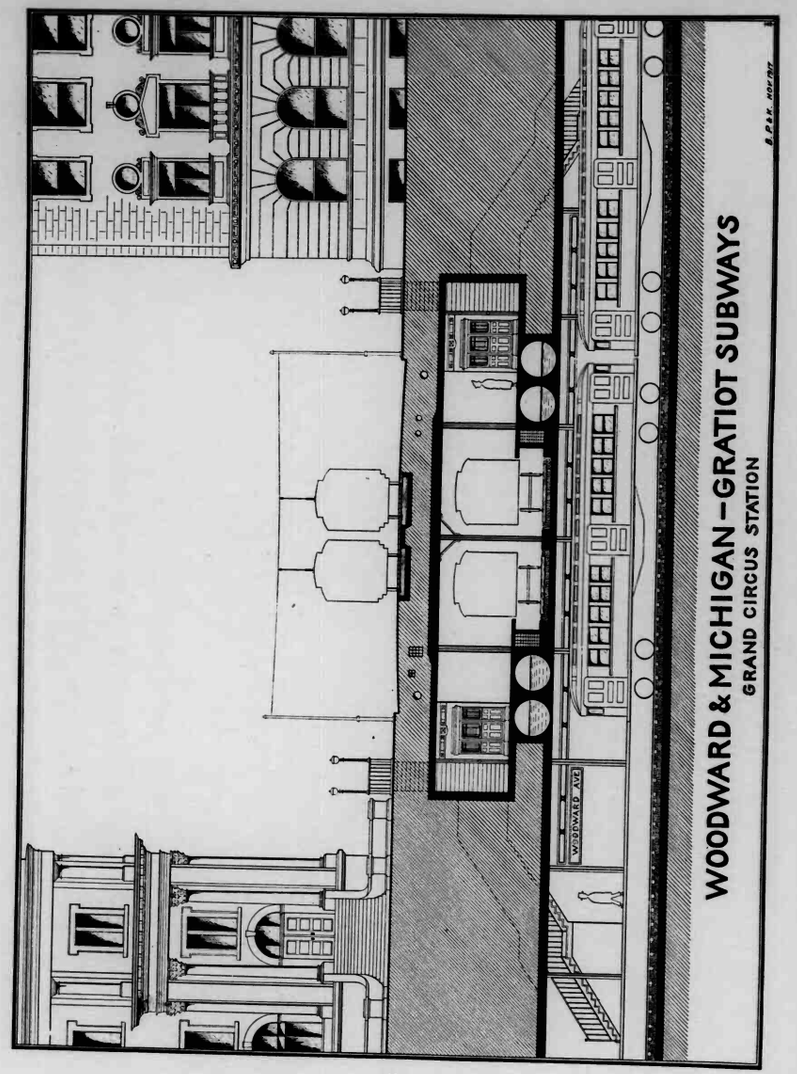
The above routes are the most probable general arteries of travel along which rapid transit in the future will be justified. The route which at present can be considered fully warranted is that on Woodward avenue.

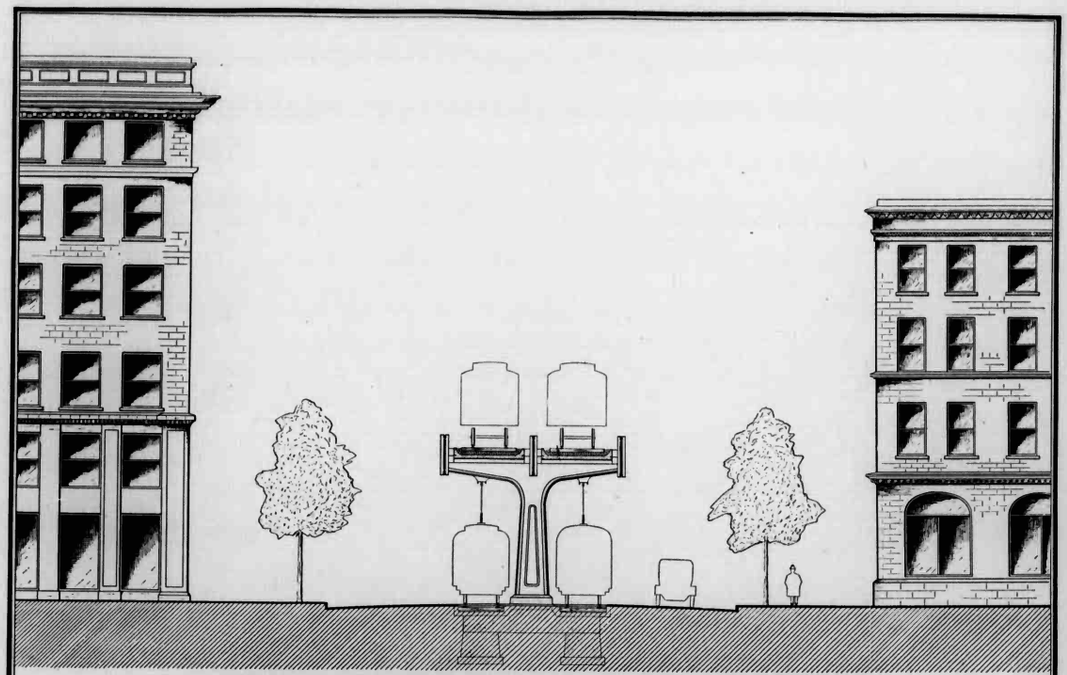
Types of Rapid Transit Construction—Subway and Overhead

In order to lay out a financially possible system, which may be realized within a reasonable length of time in such a situation as that presented by Detroit, the necessity for low construction cost is obvious.

In the heart of the City, where the congestion of vehicle and street car traffic and even pedestrian crossing traffic has become very serious, no other solution than by a subway system is possible. When, however, this extremely congested central district is relieved, further extension of subways seems of doubtful advisability as a general method of reaching the many outside residential districts of a radial city, and for such extension overhead railways are recommended.

The subway system laid out on map 3 is to have a main north and south two-track trunk line on Woodward avenue from Woodbridge street to north of Grand Boulevard, where a portal will allow the trains to rise to the surface and by an incline to reach overhead tracks extending to Manchester avenue and later to the City limits. This subway is to be crossed by an east and west low level subway line at Grand Circus. At this point it is intended to ultimately develop a general transfer station of large capacity, as shown on diagram, page 43, Grand Circus being selected for this purpose in order to separate this passenger movement from the present congestion at the City

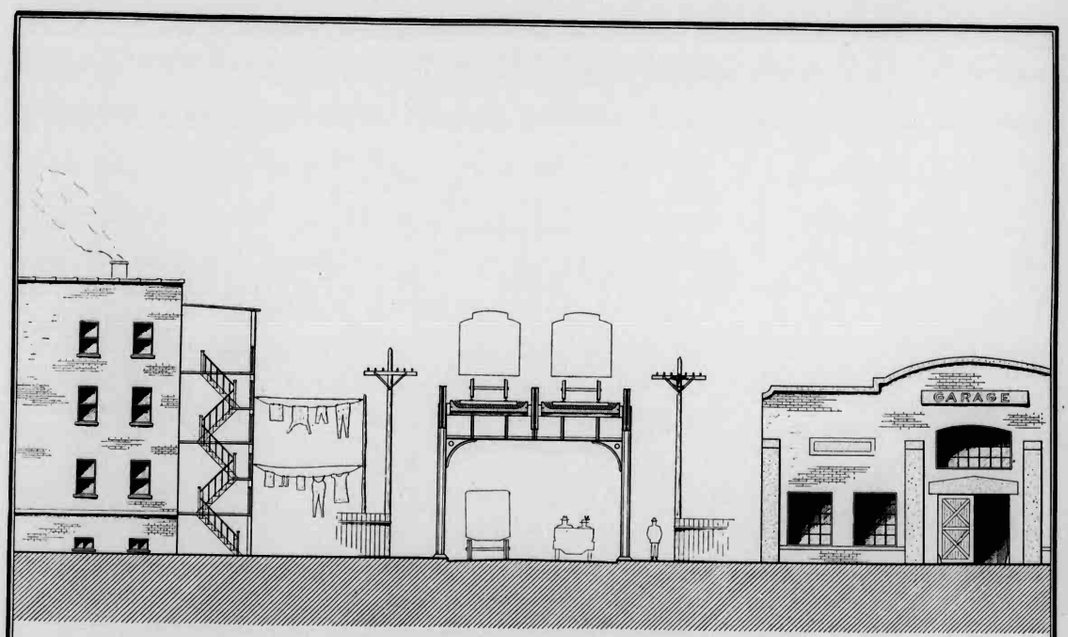




PROPOSED OVERHEAD RAILWAY ON 100 FT. STREET

CENTER COLUMN CONSTRUCTION

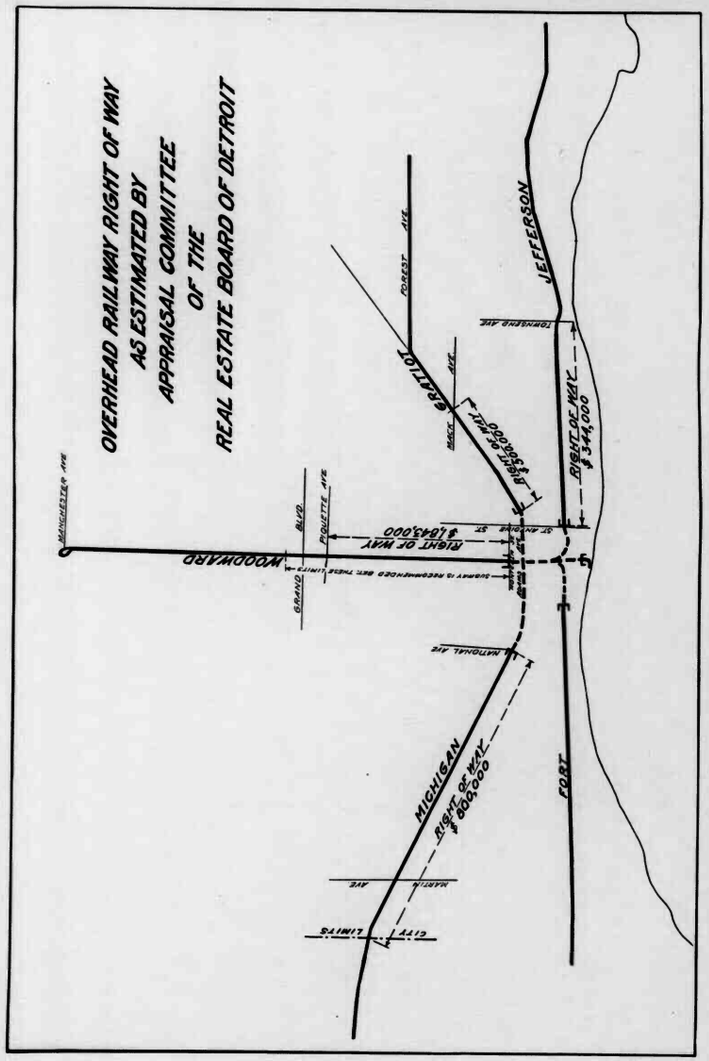
B.P.&K. NOV. 1917



OVERHEAD RAILWAY ON PURCHASED RIGHT OF WAY

VEHICLE THOROUGHFARE PROVIDED

B.P.&K. NOV. 1917



Hall and to aid in the extension northward of the retail and business district. The east and west subways on the Fort-Jefferson and Grand River lines are shown of only such length as are absolutely necessary to reach territory where property can be obtained at reasonable cost for overhead railway location or where portals can be located with minimum obstruction of cross streets.

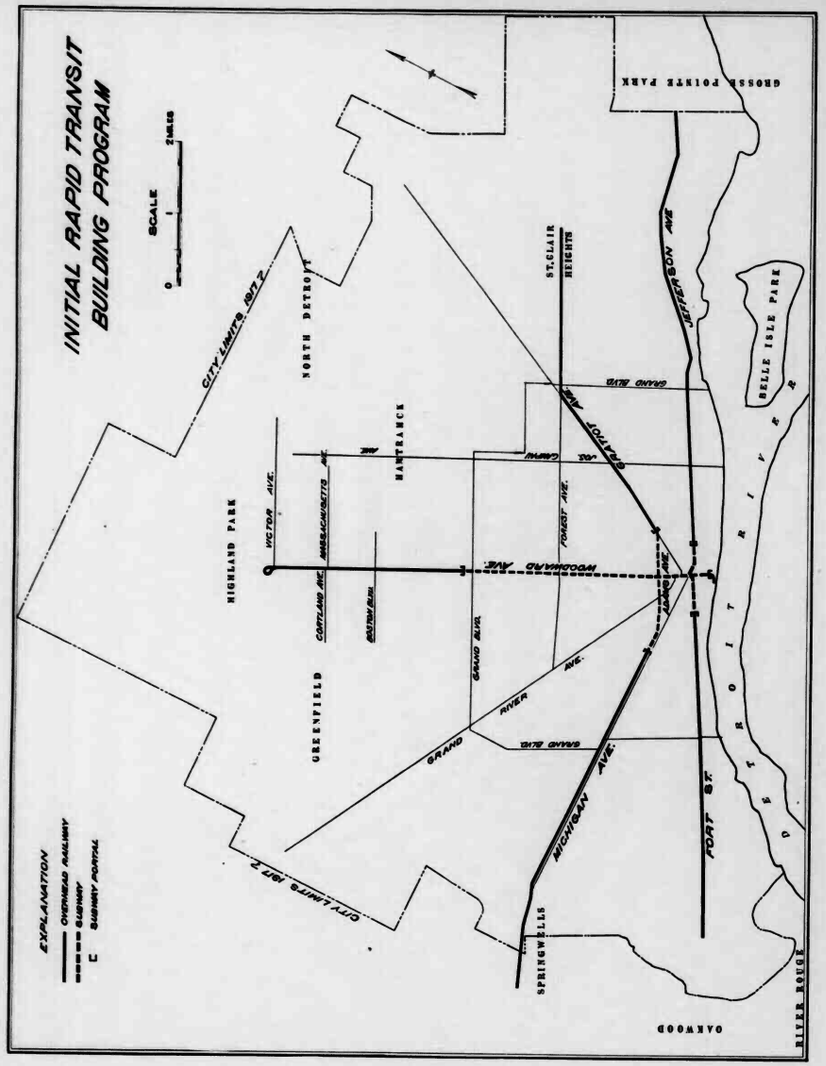
Details of the subway type of rapid transit construction have been discussed in our 1915 report.

On map 3 the portion of the routes previously described, which are shown in heavy broken lines, are indicated for subway construction and the heavy solid lines for overhead railways. It must be understood in this connection that "Overhead Railways" is not intended to mean the familiar forms of the "elevated" structures in New York and Chicago. The type suggested for Detroit is one with a solid deck with stone ballast under the tracks, thereby reducing the noises to the minimum and allowing of a much more pleasing appearance, as illustrated on page 44.

On a map of Detroit, of a scale possible to place in this report, the exact location of these lines could not be clearly shown. It is intended, however, in many cases that the overhead portions of the rapid transit lines should be built upon purchased right-of-way, using alleys and the back ends of lots. This type of construction is illustrated on diagram, page 45, showing also the valuable additions gained in opening up new arteries for vehicle traffic. Estimates of the cost of such a right-of-way have been prepared from appraisals made for the City by the Detroit Real Estate Board without charge. The portion of the rapid transit routes for which estimates of right-of-way were prepared is shown on diagram, page 46. In some cases, however, it will be necessary to occupy, at least for a portion of the way, the center of the wider streets in the outlying districts.

Where it may be necessary to locate a rapid transit structure upon the street, the type shown in the accompanying diagram, page 44, is recommended. In this type a central column is placed between the existing surface car tracks the latter being spread to allow clearance for the surface cars. Such a structure would offer the minimum of obstruction to the street and practically no obstruction of light or access to the sidewalks or buildings on streets eighty (80) feet wide or over.

A unified system combining the three types of construction, surface, overhead and subway, has been extensively worked out in Boston, where, however, the open type of elevated structure is used. Such a system is also exemplified in Philadelphia and was the basis of the recommendations for a City system in Chicago made by the Chicago Traction and Subway Commission, who reported in January, 1917. In the dual rapid transit system just nearing completion in New York, elevated structures have been extensively introduced for the outlying districts. In fact so enormous became the costs of this ex-



tended system that the resort to this form of rapid transit line was imperative. It is in fact impossible in any other way, than that above outlined, to work out a system that will cover the wide areas of relatively low population density of the American "Greater Cities." It is believed that in the plans herewith submitted the objectionable features of what is ordinarily known as an "elevated railway" have been reduced to a mininum.

Plainly stated the question of the type and extent of rapid transit to be built, ultimately depends upon how the first cost is to be met and the interest thereon is to be paid. This is discussed fully under the financial plan.

Construction Program for Initial Period

On diagram, page 48, is shown the rapid transit system, which, under the conditions assumed in the financial plan, could be developed during the first ten years after a definite policy regarding the traction problem of the City is decided upon. On this map the heavy broken lines indicate subways or underground construction, while the heavy solid lines indicate overhead railways.

The high speed line on Woodward avenue is planned to be built first as far as Manchester avenue, the underground portion extending from Woodbridge street to north of Grand Boulevard. The short subway branches for the crosstown lines could be built next and might be used by certain street car lines for the purpose of relieving the downtown congestion. These subway branches could then be extended for rapid transit and connected to overhead construction in the location and to the extent shown on diagram, page 48, or as far as the financial situation from time to time may permit. In this manner it is intended to develop as rapidly as consistent with a self supporting system and good service, an initial set of rapid transit routes which will serve all parts of the City and which will be fed by transfer from a network of surface lines leading through and from the less densely settled districts of the City.

Surface Line Extensions

The solution of the transit problem of Detroit depends only partly on the construction of a rapid transit system. The surface line system also will have to be developed to supply local traffic within the growing districts and to serve as feeders to the high speed lines.

It is estimated that for the anticipated population growth and considering the necessary extension of the city limits, an average yearly increase in the surface system of about six miles of single track will be needed.

On map 3 a system of street car extensions, designed to serve directly all residential districts as they grow, has been laid out. These extensions are planned to not only carry short haul passengers, but also to supply easy means

of reaching the rapid transit lines by free transfers and possibly by development of special transfer stations.

The question of the order of construction will have to be decided every year by agreement between the Street Railway Commission and the Company, but the additions should always be made so as to increase the service, which the surface lines are expected to render as feeders for the rapid transit system.

Interurban Lines

Provision is to be made for operating the interurban cars over the rapid transit, overhead and subway, lines. The advantage to both passengers and companies in entering into the heart of the City, avoiding all street congestion, is obvious. This will warrant a considerable investment by the Interurban Companies either in concessions as to the use of their existing surface tracks, as the City limits are extended, or in actual contributions towards the cost of the terminal facilities supplied to them.

CHAPTER III

BASIS OF UNIFIED OPERATION

A Single Unified System of Surface and Rapid Transit Lines Whether Privately or Publicly Owned or Operated

In most American cities surface lines and rapid transit lines have been developed as independent and competitive systems. A study of the resulting conditions at the present time in these cities shows clearly from the standpoint of the public, the investor, and the railway companies themselves that, could a carefully designed unified system be substituted for the competitive lines built during the past twenty years, much more desirable results for all concerned would now be obtained. The creation of such a unified system, of course, means a monopoly of city transportation, which, in the interest of the public, demands definite and skillful public regulation.

It has been clearly shown that the continued operation of competitive systems in a city, in order to be beneficial to the general public, requires such a rapidly growing patronage as will allow the business to carry a duplication of investment. In competitive traction situations the history has been that ultimately one or the other of the competitors has failed to receive sufficient return upon his investment to continue the struggle, and either a division of territory has resulted or the competing lines were consolidated and merged into one company. The unnecessary duplications of lines and investment then become apparent, but the lines being built and habitually used by patrons located along them, the latter's interests must be considered. Then follows the usual story of lines not only loaded with duplicated investment but maintaining unnecessary duplication of service, thereby burdening the entire system with an uneconomic operating condition that reacts directly upon the quality and quantity of service that can be rendered to the public.

Assuming a self-supporting city transportation system, operated under commission supervision, the fact is that the gross revenue to be obtained is limited within quite a narrow margin. The number of riders and the rate of fare cannot be greatly varied by regulation except that added facilities usually increase the travel. It, therefore, is of the greatest importance to the public not only to see that proper regulation of operation and fares is maintained but also that the capital invested is so distributed as to give maximum service for the money expended.

Detroit at the present time is at the threshold of the rapid transit period and if due heed is paid to the warnings contained in the experience of cities

that have already entered this stage in their development, it should be possible to lay out a system giving the public maximum service with the minimum of expenditure. With only a single surface line system in existence, a great opportunity is presented for producing a plan whereby a duplication of investment in rapid transit and street car lines may be avoided and the maximum of service obtained.

In a city with the size and physical characteristics of Detroit, the building of an independent rapid transit system competing with the existing surface lines would be a very doubtful financial venture. On the other hand the development of a rapid transit system as a part of a single unified system for the City presents quite a different and much more favorable situation. Both these points will be clearly brought out in the discussion of the financial plan.

TIME SAVED BY USE OF PROPOSED RAPID TRANSIT LINES AGAINST PRESENT SURFACE CAR SCHEDULES

From	To	Via	Time of Journey		Saving by Rapid Transit
			Street Car	Rapid Transit	
Woodward and Manchester Aves.	Forest . . .	Woodward .	25 min.	15 min.	10 min.
	City Hall . .	Woodward .	38 min.	23 min.	15 min.
	Woodmere and Fort .	Woodward and Fort .	68 min.	42 min.	26 min.
	Jefferson and Alter Road	Woodward and Jefferson	73 min.	49 min.	24 min.
City Hall	Woodmere and Fort .	Fort	30 min.	19 min.	11 min.
	Jefferson and Alter Road	Jefferson . .	35 min.	26 min.	9 min.
Michigan and Livernois	City Hall . .	Michigan . .	26 min.	15 min.	11 min.
	Gratiot and Harper	Michigan and Gratiot	54 min.	34 min.	20 min.
City Hall	Harper . . .	Gratiot . . .	28 min.	19 min.	9 min.

Service Greatly Improved by Unified Operation

Besides the financial considerations a much more convenient service is possible to the public, where a system is maintained with single unified operation giving transfers between surface and rapid transit lines and where surface lines are arranged as feeders for the high speed trunk lines in the outlying districts. This tends to increase the use of surface cars for short

haul local business, and the carrying of passengers on the longer trips by trains on the rapid transit system.

An automatic division of these two classes of passengers is thus arrived at, resulting in the relief of the congestion and crowding of surface cars. The greatest benefit to the public, however, is obtained by the very considerable reduction of the time of long distance travel, a few examples of which are shown in the preceding table.

A Single Uniform Fare for the Whole City With Free Transfers Between Surface and Rapid Transit Lines is Proposed and Considered Desirable

There are several divergent views as to the proper financial relation of a city transportation system to the public. Without attempting a discussion of this complicated subject, a statement may here be made, that it is at least a thoroughly defensible proposition that the riding public should pay a fare sufficient to support the system which they use and that this service should not be a burden upon the general taxable property of the city. The plans herein outlined are worked out upon this basis.

The convenience of a single uniform fare over the entire city is universally recognized. The advantages and justice of such a uniform fare with transfer privileges may be seen by examining the facts developed in our present investigation. Take for instance the operation of a rapid transit system on Woodward avenue as an initial step. Should this be found to require an increase of the present fare throughout the City in order to support the new investment, it would at first sight appear to involve the taxing of the riders in other parts of the City for the benefit of the Woodward avenue passengers. The fact is, however, that only about half of the passengers on Woodward avenue begin and end their trip on that line while the other half reach Woodward avenue by transfer from some intersecting line and 18 per cent of these by two transfers, using two other lines and most of them coming from remote parts of the city. With a rapid transit system, as proposed, in the fully developed system this proportion of people using both systems would be maintained and probably increased. In other words the benefits of high speed transportation would be well divided between all districts of the city and the utilization of rapid transit by the public generally on particular lines would be found fairly evenly divided with those using only surface or only rapid transit.

The question of a uniform fare for different lengths of rides and on heavily trafficked and lightly trafficked portions of the same system has been passed upon by some of the public regulating bodies, notably the Public Service Commission of Massachusetts, one of the oldest and most conservative bodies of this nature. In their report and order upon the Middlesex & Boston rate

case, October 28, 1914 (P. S. C. 553), they lay down as sound the policy of a flat rate within reasonable limits:

> "Our population centers profit in many indirect ways from street railway lines ramifying into rural sections. This policy of a flat rate within reasonable limits which does in effect require short ride patrons to contribute to the larger cost of the long rides, has been the policy of the Commonwealth for many years. It really underlies the five-cent fare provision of the Elevated and West End companies in metropolitan Boston."

It must be understood that this uniform five-cent fare provision here referred to applies to the use of surface and elevated lines and universal transfers practically over the whole area of the City of Boston.

The Rate of Fare Should Be Made Dependent Upon the Cost of the Service

The use of a fixed fare for a long period of years has been detrimental to the proper development of many city transportation systems and in some cases has greatly delayed the supplying of adequate service. The fixing of a permanent fare at too high a rate is unjust to the public and at too low a rate must injure the public by giving them inadequate accommodations. In the first case the system will become a subject for speculative investment and in the second case the public suffer eventually through poor service, and the company and investors by financial embarrassment.

The almost universal use of a five-cent fare for street car systems in large cities throughout the country was initiated during the horse car period or the early electric railway period and often very large apparent profits were at first realized. With the introduction of improved mechanical transportation, cable, electric, and later elevated and subway systems, the amount of investment in city transportation has increased out of all proportion to the revenue. With the present system of Public Service Commission control of accounting and the strict requirements for depreciation reserves and sinking funds, the former apparent profits have, in many instances, practically disappeared.

In Boston, on the unified surface, elevated and subway system, under rigid public service regulation, one dollar of revenue in 1897 was received upon $2.96 invested, while in 1916 this investment had increased to $6.39 for one dollar of annual revenue. With a fixed five-cent fare the inevitable ultimate embarrassment of the company is obvious. In no other line of business has the price of the commodity produced been fixed and the development of the business and the quality of the output forced to conform without damage to the product, and this condition is at the root of the trouble experienced with city transportation systems both by the public and the companies.

In the plan submitted in this Report it is proposed to make possible, under Commission regulation, a change in fare with change in cost of the service. The limiting conditions are to be the quality and quantity of service, the actual cost of operation and a return on the investment, such as will secure the necessary capital for the undertaking.

System To Be Self-Supporting

The condition of maintaining, out of earnings, an adequate return on the investment over and above operating expenses, embodies the essential requirements of a self-supporting transportation system, as proposed herein. The entire unified system as herein contemplated is to be built, equipped and financed on the basis of actual cost. If the City wishes at any time to increase the rapid transit system beyond the self-supporting limit, as is proposed in Philadelphia and as has been done in New York, it may do so under this plan, as a method of accelerating the building program. In such an event, however, the City must provide for the payment of any additional interest charges, if so incurred, by levying taxes.

The plan here laid out is estimated to be self-supporting on an average fare of five cents, with free transfers throughout the thirty year period up to 1950. This figure of five cents is used, not to indicate a fixed fare, but quite the contrary. The calculation of the elaborate earning tables with changeable rates of fare, introduced so many elements of pure conjecture that the attempt to use such changeable fare was abandoned. The fact that rapid transit service by subway and elevated is a higher class and necessarily more expensive method of travel must be clearly understood. In New York the original subway system, taking the cream of the city's rapid transit business, has been profitable, but in no other city have even the less costly elevated lines been successful business ventures. In New York the necessary recent additions to the subway system have been possible only by the city guaranteeing the interest return on the investment and being prepared to pay deficits out of annual taxes.

Neither Detroit nor any other similar city can hope to secure the large amounts of capital necessary for the initial construction period of a modern rapid transit system, and to pay the fixed charges on such expenditures out of a fare below five cents. If it is decided that the present fare is the maximum contribution which the traveling public is willing to make towards the service they desire to obtain, then it must be clearly understood that the improvement in transportation must be paid for out of general taxation, as we find it impossible to design any adequate system which will be self-supporting during the development period at less than an average five-cent rate of fare.

But what conditions may arise in the future or what density of traffic may be developed to improve the earning conditions and possibly allow of a reduction of this fare cannot safely be predicted. In the following chapter on the financial plan the question of fare is further discussed from the point of view of the cost of the physical construction.

In the conclusions and recommendations it is proposed that this question of fare be placed under the control of the Street Railway Commission and the fare based upon the cost of the service.

CHAPTER IV

FINANCIAL PLAN

General

A definite financial plan is quite as necessary for the successful development of a rapid transit system from the City's standpoint as is a physical building program.

If a judicious investment of city money is to be secured, a joint plan for division of the financial burdens between the City and the existing Company must be devised and agreed upon in advance. A plan of this nature, involving the sale of large bond issues by both City and Company, must be worked out on lines which experience has shown control the successful sale of such securities to the general public.

The financial plan hereinafter submitted starts on January 1, 1922, as being the date when the first rapid transit line is assumed to be put in operation.

The underlying idea of the financial plan is a unified system of rapid transit and surface lines with a uniform fare over the whole area of the city and free transfers between rapid transit and surface lines. The City will build the physical structures of the rapid transit lines with money raised on its own credit or with its own cash. The successively necessary surface line extensions as well as all the equipment necessary to operate both the rapid transit lines and the surface lines are to be financed and furnished by the Company.

A partnership arrangement is thus created between the City and Company, the City supplying its credit for reduction of interest charges, and the Company its plant and organization. All returns upon capital are to be limited to bonafide investments and only at such rates as are necessary to secure new capital as needed; the net divisible surplus to be equally divided between the City and Company, and all to be administered under complete Commission regulation.

The establishment of a comprehensive financial plan necessitates the forecasting of three basic items within the period covered by the plan:

1. The probable gross operating revenue of the proposed unified system.
2. The operating ratio to be applied in providing for the payment of operating expenses, maintenance, depreciation and taxes. The gross operating revenue, less these payments, will give the net operating income.

3. The method of financing to be followed, both as to the securing of the necessary capital and as to the division of the operating income into interest, sinking fund and net divisible surplus, on a fair basis, between the City and the Company.

1. GROSS OPERATING REVENUES

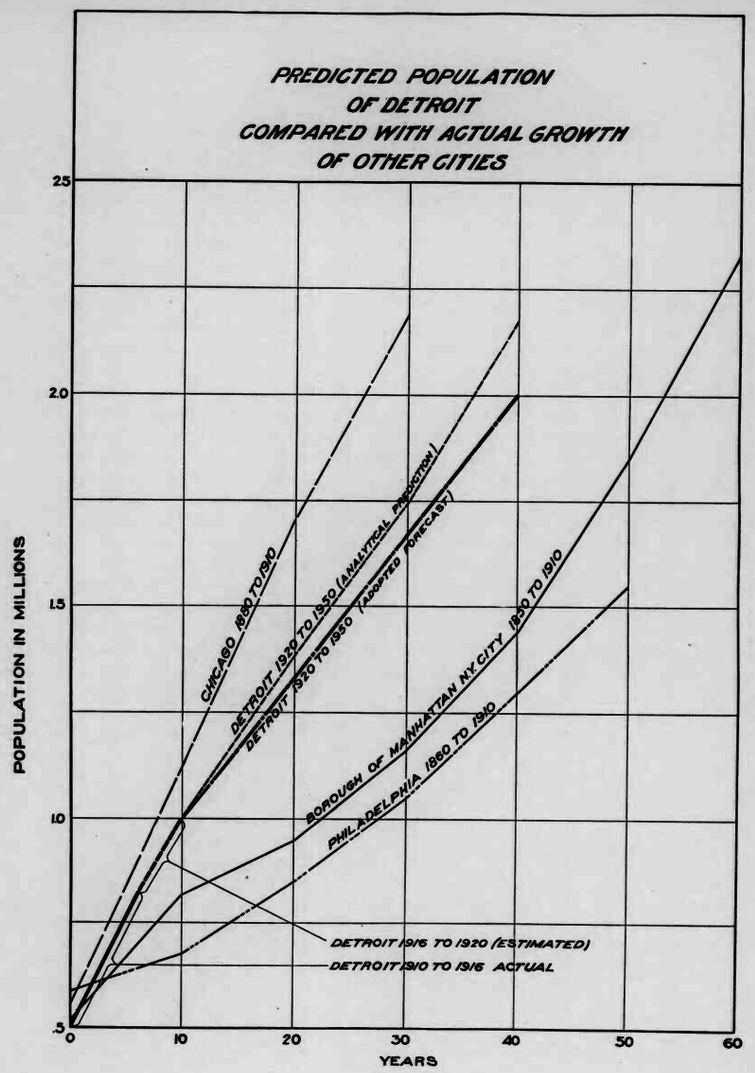
The gross operating revenues of the City transportation system, as here used, are those derived from fares paid by the passengers carried, no estimate having been attempted of the minor sources of income. It is evident that the passenger revenue is dependent upon the population of the City, upon the riding habit and upon the fare.

Population

The forecasting of the population growth of any city or community is exceedingly difficult on account of the very large number of variable factors entering into the problem. There are no two cities in the country, which have grown in an entirely similar way even if at certain time-points their population happened to be the same. For instance, the populations of Chicago in 1880, of Philadelphia in 1860 and of Manhattan in 1850 were practically the same as the population of Detroit in 1910. In the subsequent thirty year period, however, Chicago grew from about 553,000 to about 2,185,000; Philadelphia from about 585,000 to about 1,046,000, and Manhattan from 515,000 to 1,164,000, as shown on diagram, page 59. It is obvious from the foregoing that the case of every city is an individual one and that direct deductions based upon identity of size alone, regardless of period and of other governing conditions have very little value in estimating the future population of another city.

The geographical location, the importance of a city as a terminal or transit point, the business conditions prevailing, the national policies of the country and a number of other considerations have much greater bearing upon the population growth of a city than the natural causes, i. e., the birth and death rate. This makes it impossible to submit the problem to a strict mathematical analysis. An analytical method, however, has been worked out as a guide in the prediction made in this report. The details of this method are submitted in the Appendix. The results of the analytical investigation are plotted on the diagram in dotted lines, showing an estimated population of Detroit in 1930 of 1,380,000; in 1940 of 1,740,000, and in 1950 of 2,170,000.

That part of the Detroit population curve, which is plotted from known data (1910-1916) shows practically the same slope as the Chicago curve from 1880 to 1890, but the estimated portion of the Detroit curve presents a decidedly flatter slope than the curve of Chicago's actual growth. This is reasonable, considering that the geographical location of Detroit is not as



favorable as that of Chicago, which latter city is the natural railroad center of the whole country, and within the period of its rapid rate of growth was the eastern outlet of the then developing western half of the United States. Under normal conditions we would not hesitate to accept the theoretical curve as the basis of a conservative estimate of the future growth of Detroit, but having in mind the inevitable reaction upon industrial conditions of the coming termination of the war and the almost certain reduction in immigration and even possible emigration from this country, we have set the limit of the population in 1950 considerably lower than this theoretical curve would show, namely, at 2,000,000 people. In order to be thoroughly conservative we have assumed that the growth to this 2,000,000 figure will, from 1920, be in equal yearly increments of 33,000 people, assuming that the population in 1920 will reach the 1,000,000 mark. This latter figure was predicted in our previous report and we confidently expect it will be realized.

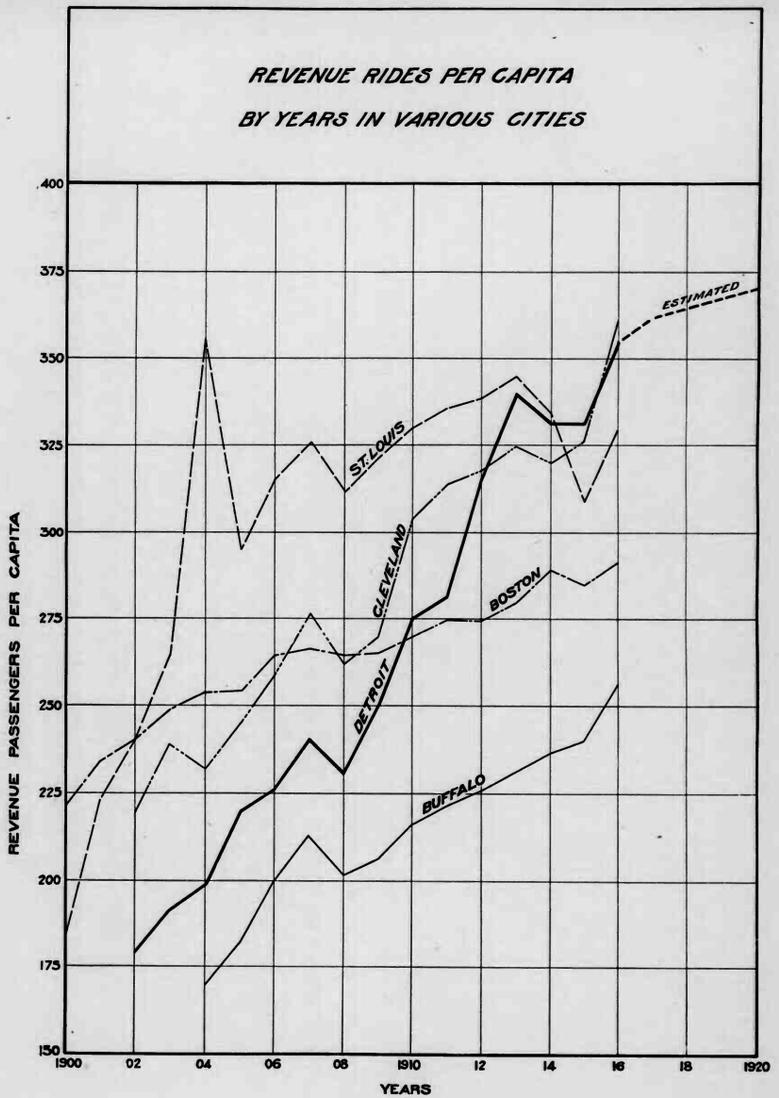
Riding Habit

The riding habit is very conveniently expressed in terms of revenue rides per capita per annum, and it naturally grows with the size and population of the city and the facilities for transportation. This growth, however, is not in the same ratio as the growth of population and being obviously limited by an ultimate maximum, it becomes very slow when the riding habit approximates this limit. The present riding habit in Detroit is already extremely high, as shown on diagram, page 61, which gives the revenue rides per capita in several other cities of approximately the same size. The limit of the riding habit should not be set higher than 400 rides per capita in a city like Detroit, as this figure to our knowledge has only been exceeded in the Borough of Manhattan, New York City, where, however, the conditions are entirely different from those ever to be expected in Detroit on account of the very large suburbs and cities in the immediate vicinity of Manhattan. In order to be conservative in our estimate the increment in the revenue rides per capita has been assumed to be uniform from 1920, namely, one per annum.

Fare

In the preparation of this report it has been necessary to work out in full detail a large number of financial plans in which varying rates of fare, interest charges, methods of participation in the financing by the City and Company, and different standards of service have been assumed. In this Report only one of these plans has been shown in detail and has been selected as securing most nearly a first class service to the public at lowest cost.

In order to make possible the financing of a rapid transit system, such as we believe Greater Detroit will some day demand, it has been necessary to utilize City credit as now permitted by charter. Even with this financial



help, a uniform fare for the whole city, with free transfers between rapid transit and surface lines can only be maintained by an average charge of five cents per revenue passenger carried. The statement that a five cent fare throughout the City is necessary will be better understood after a perusal of the subsequent discussion in this chapter covering rate of return on the investment, the necessary ratio between gross operating revenues, capitalization, etc. The obvious necessity for this raising of the present rate of fare may be readily seen by comparing the cost of the existing type of transportation system with that which is proposed. Taking the same length of track, namely, from the river straight out Woodward avenue to Manchester avenue, the following round figures may be used for comparison:

Woodward Ave.	Construction Cost	Annual Interest Charges at 6 per cent
2 Track Street Car Line	$625,000	$37,500
2 Track Elevated Line	5,000,000	300,000
2 Track Subway Line	15,000,000	900,000

It will be seen, therefore, that a two-track elevated system of the improved type discussed in this report would cost eight (8) times and the subway twenty-four (24) times as much as the existing surface car line. It must be remembered, furthermore, that the fixed charges on this new investment are an additional burden over and above that carried by the existing system, for we are here discussing a unified transportation system, rapid transit and surface, which shall be self-supporting. Assuming that the present City surface line system represents an investment of $30,000,000 it is obvious that a Woodward avenue subway would increase the fixed charges 50 per cent on the combined system. The addition of the first crosstown rapid transit line, together with the necessary extensions of surface lines and rapid transit and surface line equipment, as proposed herein, would more than double the fixed charges.

Comparison of Cost and Fixed Charges on Transit System Without and With Rapid Transit

Item	System	Cost	Interest at 6 per cent
A	Present D. U. R. city surface lines and equipment	$30,000,000	$1,800,000
B	Item A, with Woodward avenue subway and elevated, and equipment	51,000,000	3,060,000
C	Item B, with and east and west subway and elevated, and equipment	68,000,000	4,080,000
D	Item C, with surface line extensions to facilitate transfers between rapid transit and surface lines	75,500,000	4,530,000

The City lines of the existing D. U. R. system under their present rate of fare (six, seven and eight tickets for 25 cents) do not produce a revenue sufficient to pay more than a very moderate return on the foregoing valuation of $30,000,000 even with the heavily loaded street car service, as at present given. The possibility of maintaining the present rate of fare is shown to be due to the constantly increasing number of total passengers per car mile with an equally steady falling off in the speed on practically every line in the City, as shown by the operating statistics of this system on page 64 and graphically on diagram, page 65.

An exhaustive analysis of the situation in other cities proves the futility of undertaking the introduction of a rapid transit system in Detroit that can be financed even with City credit at an average fare of less than five cents per revenue passenger. Practically all the street railway systems east of the Mississippi river are to-day petitioning their respective Public Service Commissions for an increase in fare or other financial relief and this in spite of the fact that they are already receiving five cents per revenue passenger and on many of these railways the transfer privileges are not at all comparable with the almost universal transfer system in Detroit.

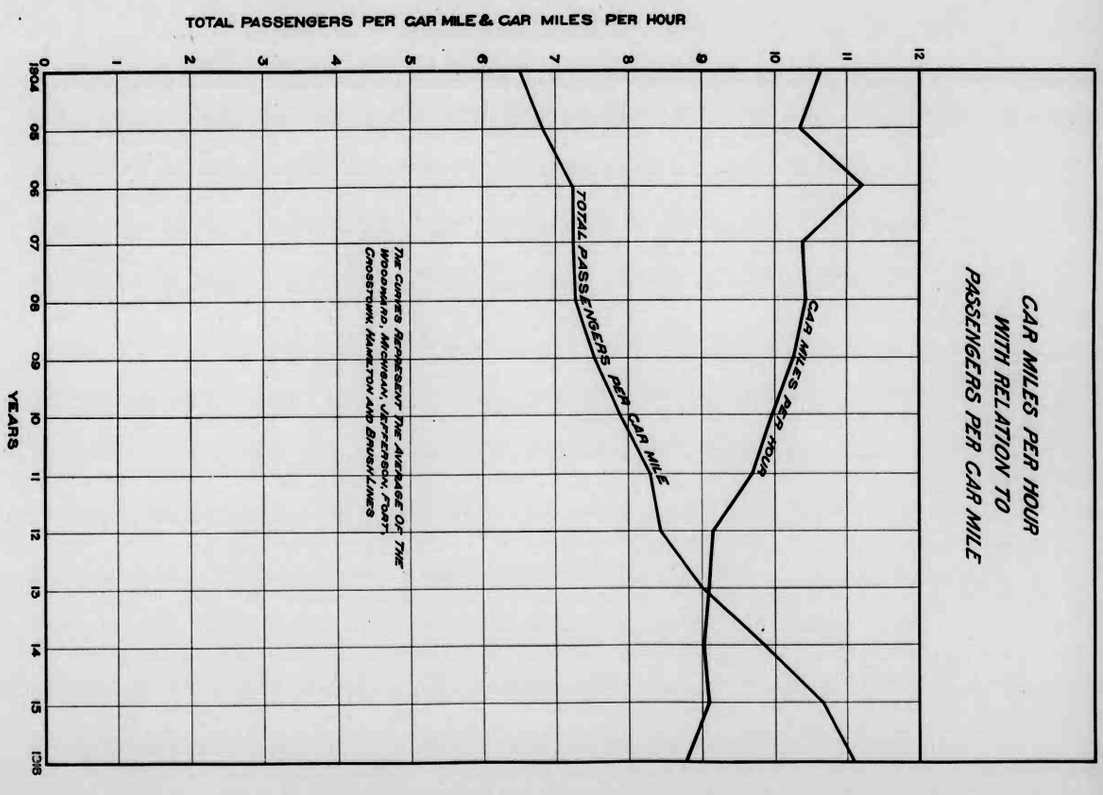
A study of the statistics of these roads shows that many of them have been under commission control in both operation and finance for a considerable period of years. Some of them, like Boston, have issued their securities with the approval of their respective boards of control during their entire corporate existence. With companies so constituted, the inference that their present financial embarrassment is due to excessive capitalization is, of course, removed. A further study of their statistics indicates that their present condition became acute prior to the year 1917. The lack of adequate revenue dated back of the tremendous rise in wages and cost of materials, which has so seriously increased operating expenses during 1917. This fact discourages the hope that the difficulty is only temporary.

In view of these facts, and of the arguments set forth in detail in the preceding chapter of this report, in order to support a sound and conservative estimate of construction and operating costs, it has been considered necessary to establish an average revenue passenger fare of five cents as the basis for the financial discussion. That it may be possible to reduce this fare under greatly improved financial conditions after the war, or on the other hand that conditions might require even a higher fare, leads to the recommendation that this question of fare should be made subject to revision under suitable control by the Board of Street Railway Commissioners.

The gross operating revenue for Detroit's improved unified system therefore, has been figured on the basis of a population of 1,000,000 in 1920, increasing by equal annual increments to 2,000,000 in 1950; on the basis of 370 revenue rides per capita in 1920, increasing by increments of one per

COMPARATIVE STATEMENT SHOWING INCREASE IN PASSENGERS PER CAR MILE AND DECREASE IN CAR MILES PER HOUR, 1904-1916

Year	Woodward		Michigan		Jefferson		Fort		Crosstown		Hamilton		Brush		Average	
	Total Pass. per Car Mile	Car Miles per Hour	Total Pass. per Car Mile	Car Miles per Hour	Total Pass. per Car Mile	Car Miles per Hour	Total Pass. per Car Mile	Car Miles per Hour	Total Pass. per Car Mile	Car Miles per Hour	Total Pass. per Car Mile	Car Miles per Hour	Total Pass. per Car Miles	Car Miles per Hour	Total Pass. per Car Mile	Car Miles per Hour
1904	6.72	10.80	6.83	10.30	5.94	11.20	5.26	10.50	6.14	13.30	7.22	9.20	7.39	9.20	6.50	10.64
1905	7.07	10.00	7.11	10.10	6.30	11.20	5.69	10.60	6.38	12.80	7.75	9.00	7.28	8.90	6.83	10.33
1906	7.32	11.50	7.49	11.30	6.60	12.00	5.77	11.40	7.20	13.90	8.35	9.80	7.96	8.80	7.24	11.24
1907	7.29	10.50	7.30	10.20	6.79	10.90	5.80	10.20	7.25	13.20	8.20	8.90	8.05	8.50	7.24	10.34
1908	7.50	10.90	7.46	10.20	6.91	10.90	5.86	10.60	7.22	13.20	8.45	8.80	7.38	8.30	7.25	10.41
1909	7.67	10.60	7.69	9.80	7.16	10.90	6.28	10.20	7.32	13.20	8.66	9.00	8.07	8.10	7.55	10.26
1910	7.86	10.00	8.08	9.60	7.04	10.40	6.73	10.30	7.68	12.80	9.38	8.50	8.58	8.20	7.91	9.97
1911	7.95	10.20	8.60	9.50	7.49	10.00	7.19	10.30	8.06	11.20	9.87	8.30	8.94	8.10	8.30	9.66
1912	7.91	9.90	9.02	9.20	8.10	9.30	7.82	10.10	8.22	9.20	9.15	8.60	9.78	7.90	8.57	9.17
1913	8.54	9.70	9.52	9.00	8.71	9.40	8.77	9.80	9.59	8.90	8.02	9.20	10.20	7.80	9.05	9.11
1914	9.92	9.40	10.20	8.90	9.85	9.20	9.17	9.60	10.95	9.00	8.78	9.20	10.80	7.80	9.95	9.00
1915	10.35	9.60	11.10	9.00	10.15	9.70	9.94	9.40	12.70	9.20	9.39	9.20	11.30	7.70	10.70	9.11
1916	10.05	8.74	11.20	8.80	10.67	9.10	10.35	9.20	12.95	9.00	10.00	9.20	12.67	7.30	11.13	8.76



annum to 400 revenue rides per capita in 1950 and on the basis of an average fare of five cents per revenue passenger. Considering the high wages earned in the industries of Detroit, and the improved service rendered to the public by the unified traction system, it is believed that the adverse influence of the change to a higher fare upon the riding habit will be quickly overcome. The conservative increase assumed in rides per capita should make these estimates of gross operating revenue safe.

2. OPERATING RATIO

By operating ratio is meant the per cent of the gross operating revenues, which it is necessary to expend to operate the system, i. e., all labor, power, and general expense, expenditures for labor and material to maintain the property in an efficient condition, the amount necessary to provide for depreciation, and the payment of taxes, which the system has to bear. It is evident that the cost of all these items is not dependent on the rate of fare, but is mainly dependent upon the grade of service rendered, upon the cost of labor and materials, and upon the adequacy of the provisions made for maintaining and renewing the property.

In a computation covering a period of thirty years and with the initial period seriously affected by the present war conditions it is obvious that no single uniform operating cost can be expected to be maintained for the entire period. It is, however, absolutely necessary in working out the financial plan, to assume an operating ratio, which will represent a safe, conservative average of the probable actual cost of operation.

Statistics of existing rapid transit (elevated and subway) systems, show that their operating ratio is considerably lower than that of street car lines. The addition, therefore, of rapid transit lines to a city transportation system would naturally decrease the average operating ratio of the system. On the other hand, the past few years and particularly the last year, have shown a rapid increase in the cost of operation of practically all electric railways in the country. In the eastern district of the United States, namely north of the Ohio and east of the Mississippi, the first six months of the year 1917 showed an average operating ratio of 67.89 as against 63.67 for the same period of 1916, an increase of 6.6 per cent.

The foregoing figures are here introduced not to show the numerical amount, but to show the relative increase from 1916 to 1917. The companies involved, or many of them, are quite different in character from the Detroit city system. The Boston Elevated for the year 1916 showed an operating ratio of 70 per cent for its combined system of surface, elevated and subway lines. The operating ratio of the Brooklyn Rapid Transit system was 64.8 per cent in 1917. As a safe average for the period of 1922-1932 in the proposed combined Detroit system and in order to provide a thoroughly

first class service and adequate maintenance and depreciation, we have used in the following tables a ratio of 70 per cent for the operating expenses. This figure, it is estimated, will provide 18 per cent of the gross operating revenues for maintenance and depreciation. After a period of ten years a further depreciation charge of one per cent and increasing to two per cent after another five years has been added, resulting ultimately in a total allowance of 20 per cent for maintenance and depreciation, and in an operating ratio of 71 and 72 per cent respectively.

3. METHOD OF FINANCING

City vs. Company Financing

Financial plans for an independent rapid transit system on a competitive basis show such poor earnings as to make the financing of the system impossible by a company, and a heavily loosing venture if attempted by the City.

A plan for the financing of a unified system, in which all capital is to be supplied by a company, results in having to obtain the capital on terms which will not leave net income sufficient to make the securities salable on the general market. This is due to the bad opinion of the public as to city transportation systems, which are not backed by city guarantees or city credit. Whatever may be said for or against the logic of this position of the public and the underlying causes, the fact remains that new bonds issued for the construction of street railway and rapid transit systems in such amounts as here contemplated. would be practically unsalable even under normal business conditions if they were based solely on the credit and estimated future earnings of the system itself.

The alternative of municipal ownership by purchase of the existing surface lines and city financing of the whole system is impractical in Detroit due to the statutory limitations on the amount, which can be raised within the two per cent limit of the assessable value of the real and personal property in the City. The sum thus available will not purchase the existing property and build rapid transit lines in addition.

The street railway bonds as provided for in Section 10 of the Statute are no more salable than those just mentioned in the case of company ownership, as they are not backed by City credit.

City and Company Partnership

By participation of both Company and City in the financing, a situation can be created whereby the lower interest rates obtainable by the City on its own bonds, and the protecting of the principal and interest on the Company's securities by the reinvestment of the City's profits in the property, will strengthen the credit of the whole enterprise sufficiently to make all the securities marketable and the interest charges a minimum.

City To Build and Own Rapid Transit Lines

It is assumed that the Detroit United Railway will segregate its holdings of street railway properties within the City of Detroit and that the ownership of those properties can be transferred to a new company to be formed, called the Company, in this Report, which will operate the whole system under the supervision of and according to the rules set down by the Street Railway Commissioners.

Toward such a partnership, the city will contribute the funds necessary to build the rapid transit lines, whose cost is kept within the legal two per cent debt limit, and which structures thus built it is to own. Subsequent rapid transit construction is to be financed by the reinvestment in the new structures of the City's share in the surplus from operation. These accumulated sums will supply the bulk of the new funds for rapid transit construction and keep the bond issue well within the two per cent debt limit.

Company To Operate System Under Terminable License

The City will grant a license to the new Company for the joint operation of the entire system until terminated by default by the Company or by the purchase of the property by the City.

On this important point the following is quoted from the Chicago Traction and Subway Commission's Report of 1916:

> "It is an axiom of finance that the greater the risk associated with an investment, the greater will be the return demanded by the investor. It is directly to the City's interest to make the security of the investment unquestionable, as the Corporation receives on new capital obligations only its actual payments for interest on these obligations. Any grants to the Corporation, which add to the security or the stability of the investment will tend to reduce the cost of new capital to the partnership, which will directly increase the divisible net receipts, of which the City gets 55 per cent."
>
> "One of the most important factors contributing to the security of the investment is the form of the franchise. It is principally for this reason that the Commissioners favor a terminable grant. Such a form of franchise relieves the investment of the uncertainties and embarrassments usually present during the later years of the life of one granted for a fixed term. A franchise settlement may, and frequently does, drag along for several years, and as long as the question is unsettled there is present in the mind of the investor the fear that the conditions which may be imposed on the Corporation upon settlement, will be such as to make the Corporation's income so small as to endanger his own principal and income. This makes the refunding of old or the issuing of new obligations more expensive, and as this cost, if any, under the Commissioner's plan, is added to the purchase price of the property on which interest must be paid before arriving at the divisible net receipts, the City suffers directly as a result of making financing difficult."

Company To Supply and Finance Surface Lines and Extensions and All Equipment

The Company will contribute the existing City street car system at a reasonable valuation as of the date of consolidation, and will furnish the capital for all the equipment of the rapid transit and surface lines and for all extensions of the street car system. The valuation assumed for the street railway system in 1917 is $30,000,000.

Only Actual Interest Rate on City and Company Funds Allowed

Upon the capital invested by each partner they are to receive from the revenues the rate of interest which they respectively must pay to secure their share of the required capital. In calculating the financial tables it was assumed that the interest rate upon the capital invested by the Company will be not over six per cent. All securities are to be issued only upon approval by the Street Railway Commissioners as to amount, price and rate of interest.

A sinking fund to retire the bonds of both City and Company in sixty years is also provided. The equity in the property, represented by the bonds retired through the operation of the sinking fund, is to revert to the City.

In working out this financial plan the complete refinancing of the entire value set upon the existing surface line properties within the City has been assumed, and the cost of this refinancing has been included in the estimates. This does not mean that such action, with its consequent added interest charge, will necessarily have to be incurred. It is quite reasonable to hope, that, when actual consolidation is effected, a more advantageous handling of this situation can be worked out through an exchange of securities. In the computation of the tables, however, the radical assumption of complete refinancing was deemed advisable in order to prove beyond question that the building program can be carried out and the proposed unified traction system made self-supporting with a reasonable rate of fare. The effort throughout this plan has been to assume that the least favorable conditions may exist after the war, and it should not be inferred, that the exact figures herein used are intended as an offer for the existing properties.

Similarly, this plan provides for the retirement of the City's traction bonds through the action of the sinking fund. It is recognized, that a more favorable showing might be made by retiring the higher rate junior securities of the Company. This has not been done in the working out of the tables, in order to keep the bonds issued by the City for traction purposes below the two per cent legal limit with a sufficient margin, so as not to impair the borrow-

ing capacity of the City, should later developments require a more extensive building program. In this as in other features not especially noted, where a choice existed, the most burdensome condition has been assumed, but not with the intention of advocating that such a procedure should necessarily be followed. If the City Charter should be amended as in New York, so that City bonds on public utilities which are self-supporting could be excluded from the debt limit, a much more favorable condition may be created.

Net Divisible Surplus Shared Equally by City and Company

The net income of the system, after setting aside the interest charges and the Sinking Fund, is to be divided equally between the City and the Company, provided the Company's income does not exceed eight per cent on its investment. The City's share in the net divisible surplus is to be subject to the payment of an agreed minimum to the Company.

Purchase Price to City

A purchase price is to be set up for the entire system which shall consist of the City's outstanding securities, plus the value of the surface car lines at the time of the consolidation, plus such actual additions as are made from time to time by the Company, reckoned at par value of the securities approved by the Commissioners to cover these last two items, less those retired through the sinking fund. Common stock issued by the Company is to have no par value and is not to be included in the purchase price. At the purchase price thus fixed less the City's outstanding traction bonds, the City may on due notice take over the property at any time.

Ownership of Property Acquired by City From Its Share in Surplus

It will be seen that in this manner the City will steadily acquire an increasing share in the ownership of the whole property, and by 1950 could purchase, free of all debt, the complete system costing $156,134,000, by the payment of $75,435,000, or by about 1970 the property would revert to the City without cost. During all of this period the City would have received a return upon its money invested, including the proceeds of bonds and its share of the surplus of from 6.78 to 20.90 per cent, while the Company is to be limited by agreement to a maximum return of eight per cent, all excess over eight per cent going to the City.

By this combination of City and Company credit and careful regulation of all expenditures and of security issues, a good service can be assured to the public at the lowest cost and safety of principal and a fair return to the investing public. Without this the burden of obtaining increased facilities must fall directly upon the taxpayers through increase of the annual City tax rates.

DESCRIPTION OF FINANCIAL TABLES

The following tables have been prepared to show clearly what would be the actual result of carrying out the plans described in the foregoing portion of this report. Opposite each table has been placed a brief explanation of each column of figures, indicating the manner in which they have been computed.

It should be noted that the columns of figures have been grouped under general headings as follows:

Expenditures for Investment in Road and Equipment—Page 77.

In columns Nos. 1 to 5, both inclusive, there is given the total cost, each year, of building rapid transit lines by the City; and the cost of building surface lines and of supplying all equipment for both surface and rapid transit lines by the Company. These columns show a very equal division of investment made by the City and the Company after the first two initial periods. Thus in 1922 the City expends $11,700,000, which investment has grown by 1950 to $68,050,000. The Company commencing with an investment of $42,680,000 in 1922, has increased its share of the investment by 1950 to $88,084,000. This results in a total of $156,134,000, by 1950, as the amount necessity for a higher fare than five cents to support the system.

The sufficiency of the transportation facilities thus provided, and its reasonableness when compared with the development of other rapid transit systems is shown by column 6. These figures (column 6) indicate that starting in 1922 with an investment of $2.34 for each $1.00 of gross operating revenue, the system has grown by 1945 to a size requiring an investment of $4.20 per $1.00 of gross operating revenue. A lower investment ratio would indicate insufficient facilities to earn the estimated revenue while a ratio of over $5.00 invested per $1.00 of gross receipts would indicate the necessity for a higher fare than five cents to support the system.

Capitalization—Page 79.

Columns 7 to 15 under the general heading Capitalization indicate the sources from which the funds for construction and equipment are assumed to be derived.

The issue of City bonds shown in column 7, occurs only in 1922, 1926 and 1932. The City's outstanding bonds (column 8) are seen in 1922 to be $11,700,000, increasing to $18,111,000 in 1926, decreasing again to only $10,787,000 by 1950, the decrease being due to the operation of the sinking fund.

Columns 9 and 10 show the investment by the City in rapid transit structures, subways and elevated, from funds derived in accumulating its

share of the net divisible surplus. The total capital thus invested by the City amounts in 1950 to $48,833,000.

The Company starting with a bond issue of $33,000,000 in 1922, plus $9,680,000 in some junior form of security, has outstanding in 1950 a par value of $64,647,000 in securities. (Columns 11 to 15.)

The right hand column (17) on this same table, placed here for convenience of reference and comparison with the related figures of capitalization, indicates the purchase price at which the City can acquire the property in any year under the proposed agreement, free of all indebtedness.

By comparing columns 5 and 17 it will be seen that in 1930 the City could acquire, free of debt, the unified system upon which had been expended $78,882,000, for the sum of $65,561,000. In 1940 the unified system would represent an investment of $114,858,000, which the City could take over, free of debt, for $71,760,000, in cash. By 1950 the amount invested in the system would be $156,134,000, which system the City would have the right to take over free of debt for $75,435,000, in cash.

Column 16 represents the equity in the property which is being gradually acquired by the City and which reduces the total investment, column 5, to the purchase price, column 17. This acquisition is effected partly through the reinvestment of the City's share of the net divisible surplus and partly through the operation of the sinking fund, the equity corresponding to the retired bonds reverting automatically to the City. The cumulative total of all the bonds which are retired can be found for each year by deducting column 10 from column 16.

In a subsequent table, column 36, will be found a traction fund representing the City's uninvested earnings which have been accumulated over and above those required for the building program here assumed. By 1950 this fund would amount to $25,642,000, which would enable the City to purchase the complete traction system, which cost over $156,000,000, by the investment of $50,000,000, additional cash.

Operating Statistics, Gross Operating Revenue, Operating Income—Page 81.

Columns Nos. 18 to 20, show the basis for an estimated gross operating revenue (column 21) in 1922 of $19,850,000, increasing to $40,000,000, by 1950. The operating income, column 22, shows an increase from $5,955,000, in 1922 to $11,200,000 in 1950.

Interest and Sinking Fund—Page 83.

The first four columns, 23 to 26 inclusive, show the payments for interest on the various securities issued against construction and equipment by both the City and the Company, all under the regulations of the Street Railway Commission. Column 27 shows the amounts devoted each year to the retirement of the outstanding bonds through the action of the sinking fund. Column 28 shows that the total deductions from operating income applicable to these purposes, which in 1922 amount to $3,561,000, will increase to an annual amount of $7,887,000 at the end of the period.

Distribution of Net Divisible Surplus—Page 85.

The table consisting of columns 29 to 35 indicates the distribution of the net divisible surplus between the Company and the City and the rates of return, which each will receive upon its investment from year to year. The last column, 36, shows the traction fund or the City's uninvested earnings previously referred to. Column 32 shows that the Company receives a maximum return of eight per cent and a minimum of 6.94 per cent throughout the period under the conditions here assumed, it being contemplated that some such limits would be maintained under the provisions of the agreement. The City (column 35), during the same period, has received returns ranging from 20.9 per cent to 6.78 per cent with a general average above eight per cent. No attempt has been made, in working out the financial plan, to adjust any of the conditions to vary these percentages. The obviously abnormal rate of return to the City in the early periods is due to its receiving one-half or more of the net divisible surplus at a time when its investment is relatively small.

It must also be noted that while the Company's rate of return, column 32, actually varies between seven and eight per cent, the City's return, shown in column 35, does not include an allowance such as the City receives by the annual additions to its ownership of the property through the working of the sinking fund. It has been assumed that this progressive acquisition of the ownership of the property by the City was a fair return for granting the Company the right to operate the system under the conditions named and for the definite assistance given by the City through its contribution in the financing and the pledging of its credit.

It should be observed that by this process of joint financing through a partnership between the City and the Operating Company, together with a practically equal distribution of the net surplus, it is possible to finance and operate the unified traction system at a very reasonable average rate of fare. By thus utilizing to the best advantage the elements which the Company and the City can contribute, a joint arrangement is made supplying adequate service as near as possible at actual cost, while properly protecting the general public who invest in the securities of both City and Company.

Financial Charts

Accompanying these tables are three financial charts showing in graphical form the same facts as contained in the tables.

Chart page 86 shows expenditures for investment in road and equipment for the unified system. The height of the ordinates above the base line indicates in millions of dollars the cost of the property at the dates given on the base line extending from 1922 to 1950. The upper line of this diagram shows the total cost of the entire unified system. The various sources, from which these funds are derived, is indicated by the shaded areas, including the cost of the original street car system, the additions to the surface lines and equipment furnished by the Company, the rapid transit lines built by the City from the sale of bonds and other rapid transit lines built by reinvestment of the City's share in the net divisible surplus.

Chart page 87 shows the same facts as chart page 86 except that the height of the ordinates here indicates the effect of the amortization of the outstanding securities, both City and Company, by the action of the sinking fund provisions of the agreement. The heavy line bounding the City's invested earnings represents the purchase price of the property to the City. The ordinates above the heavy line and extending to that marked "Total Cost of Unified System" give the value of the equity acquired by the City.

Chart page 88 shows the disposition of the gross operating revenue from the unified system. The upper line extending from $19,850,000 to $40,000,000, over a period from 1922 to 1950, indicates by the height of the ordinates the total gross operating revenue for each year. The large area at the base of the diagram indicates the operating expenses taken at from 70 to 72 per cent of the gross operating revenue. The portion above this area and below the gross operating revenue is the operating income, which is divided as indicated between interest charges, sinking fund and the share of the surplus allotted to the City and to the Company.

FINANCIAL TABLES

EXPENDITURES FOR INVESTMENT IN ROAD AND EQUIPMENT

The Date is Assumed To Be the First of January in Each Year for Columns 1 to 17 Inclusive and for Column 36

Column 1. The cost of rapid transit construction is shown in column 1, opposite the date when the individual lines are planned to go into operation, in accordance with the building program elsewhere described. These sums include the cost of financing and the interest during construction, and are supplied by the City either by the sale of bonds or by the reinvestment of both its share in the net divisible surplus and the interest earned on same. Under the conditions assumed in computing these financial tables the issuance of City bonds will not be required after the expenditures of 1932 are met. The City's share in the net divisible surplus and the interest on the reinvested earnings will thereafter provide for the City's part of the construction requirements.

Column 2. This column represents the total cost of rapid transit construction, the amounts shown in each year being the cumulative total of the sums shown in column 1.

Column 3. The cost of surface line extensions and equipment which will go into operation during each year, and the cost of the equipment of the rapid transit lines are shown opposite the corresponding date. As in column 1 these amounts include interest during construction and the cost of financing, the amounts representing the par value of the securities issued by the Company for the above purpose, subject to the approval of the Street Railway Commissioners. In the plan herein submitted it has been assumed that the Company will raise 80 per cent of its necessary funds by the issuance of bonds and 20 per cent by the sale of stock or some other junior security.

The amount, $42,680,000, shown in column 3 for the year 1922 includes the estimated cost of the D. U. R. surface line system, as at December 31, 1917, plus the cost of the equipment of the Woodward avenue subway and elevated, plus the cost of construction and equipment of surface line extensions up to January 1, 1922. The amount allowed for the value of the D. U. R. city surface line system is $30,000,000 for the track and equipment within the city limits of 1914, plus extensions to December 31, 1917.

Column 4. The total cost of surface lines, their extensions, and all equipment for both surface and rapid transit lines is shown in this column. The amounts represent the cumulative total of the amounts shown in column 3.

Column 5. This column is the sum of columns 2 and 4, showing the total cost of the entire city traction system, rapid transit and surface, with their complete equipment as in operation at the beginning of each year.

Column 6. This column shows the "Investment Ratio" for each year, being the ratio of the total investment in the unified system, as shown in column 5, to the gross operating revenue, as shown in column 21.

EXPENDITURES FOR INVESTMENT IN ROAD AND EQUIPMENT

Date	By City		By Company		Total Investment in Unified System	Investment Ratio
	Expenditures for Rapid Transit Construction in Each Building Period	Total Investment in Rapid Transit Construction	Expenditure for Surface Lines and All Equipment Each Year	Total Investment in Surface Lines and All Equipment		
Column Numbers	1	2	3	4	5	6
1922	$11,700,000	$11,700,000	$42,680,000	$42,680,000	$54,380,000	2.74
1923	. . . .	11,700,000	812,000	43,492,000	55,192,000	2.69
1924	. . . .	11,700,000	812,000	44,304,000	56,004,000	2.64
1925	. . . .	11,700,000	812,000	45,116,000	56,816,000	2.59
1926	13,450,000	25,150,000	5,268,000	50,384,000	75,534,000	3.34
1927	. . . .	25,150,000	812,000	51,196,000	76,346,000	3.27
1928	. . . .	25,150,000	812,000	52,008,000	77,158,000	3.22
1929	. . . .	25,150,000	812,000	52,820,000	77,970,000	3.16
1930	. . . .	25,150,000	812,000	53,632,000	78,882,000	3.11
1931	. . . .	25,150,000	812,000	54,444,000	79,594,000	3.05
1932	11,200,000	36,350,000	6,000,000	60,444,000	96,794,000	3.61
1933	. . . .	36,350,000	812,000	61,256,000	97,606,000	3.55
1934	. . . .	36,350,000	812,000	62,068,000	98,418,000	3.49
1935	. . . .	36,350,000	812,000	62,880,000	99,230,000	3.43
1936	7,700,000	44,050,000	4,680,000	67,560,000	111,610,000	3.74
1937	. . . .	44,050,000	812,000	68,372,000	112,422,000	3.71
1938	. . . .	44,050,000	812,000	69,184,000	113,234,000	3.65
1939	. . . .	44,050,000	812,000	69,996,000	114,046,000	3.59
1940	. . . .	44,050,000	812,000	70,808,000	114,858,000	3.54
1941	12,000,000	56,050,000	4,985,000	75,793,000	131,843,000	3.97
1942	. . . .	56,050,000	812,000	76,605,000	132,655,000	3.90
1943	. . . .	56,050,000	812,000	77,417,000	133,467,000	3.85
1944	. . . .	56,050,000	812,000	78,229,000	134,279,000	3.79
1945	12,000,000	68,050,000	5,795,000	84,024,000	152,074,000	4.20
1946	. . . .	68,050,000	812,000	84,836,000	152,886,000	4.14
1947	. . . .	68,050,000	812,000	85,648,000	153,698,000	4.07
1948	. . . .	68,050,000	812,000	86,460,000	154,510,000	4.02
1949	. . . .	68,050,000	812,000	87,272,000	155,322,000	3.96
1950	. . . .	68,050,000	812,000	88,084,000	156,134,000	3.91

CAPITALIZATION

Column 7. This column shows the par value of the bonds issued by the City at the 1st of January in the years 1922, 1926 and 1932. These bonds are assumed to be issued at par and retired by equal annual installments during a period of sixty years.

Column 8. This column shows the par value of all City bonds outstanding at the beginning of each year, being the cumulative total of column 7, less the bonds retired each year through the application of the sinking fund.

Column 9. This column shows the amounts of the City's earnings reinvested in the property at the dates shown. These amounts are derived from the City's share in the net divisible surplus (column 33), plus the interest on the reinvested sums (column 26), the whole accumulated at four per cent up to the date of the investment. Those parts of such accumulated funds which exceed the capital requirements of the City are shown in column 36.

Column 10. This column shows the total amount of reinvested earnings by the City and is the cumulative total of column 9.

Column 11. The bonds issued each year by the Company are shown in this column, the amount being figured in accordance with the explanation given for column 3. The Company's bonds are assumed to be retired by equal annual installments during a period of sixty years.

Column 12. This column is the cumulative total of column 11, less the bonds retired each year through the application of the sinking fund.

Column 13. This column shows the par value of the junior securities issued by the Company each year in accordance with the explanation given for column 3.

Column 14. This is the cumulative total of column 13.

Column 15. This column shows the Company's total outstanding securities at the beginning of each year, being the sum of columns 12 and 14.

Column 16. This is the equity in the property reverting to the City, free of debt, acquired through the action of the sinking fund and through the reinvestment of the City's share in the surplus. It is the sum of column 10 plus the cumulative total of column 27.

Column 17. This column is the purchase price, free of debt, of the whole unified system to the City at the beginning of each year, being the sum of the total then outstanding City and Company securities (column 8, plus column 15). The sum of columns 16 and 17 will equal the total investment, column 5.

CAPITALIZATION

Date	By City				By Company					Equity Acquired by City	Purchase Price to City (Cols. 8 and 15)
	Bonds Issued in Each Period	Total Bonds Outstanding	Earnings Reinvested in Each Period	Total Earnings Reinvested	Bonds Issued Each Year	Total Bonds Outstanding	Junior Securities Issued Each Year	Total Junior Securities Outstanding	Company's Total Outstanding Securities		
Column Numbers	7	8	9	10	11	12	13	14	15	16	17
1922	$11,700,000	$11,700,000	.....	.....	$33,000,000	$33,000,000	$9,680,000	$9,680,000	$42,680,000	.....	$54,380,000
1923	.....	11,505,000	.....	.....	628,000	33,078,000	184,000	9,864,000	42,942,000	$745,000	54,447,000
1924	.....	11,310,000	.....	.....	628,000	33,146,000	184,000	10,048,000	43,194,000	1,500,000	54,504,000
1925	.....	11,115,000	.....	.....	628,000	33,203,000	184,000	10,232,000	43,435,000	2,266,000	54,550,000
1926	7,191,000	18,111,000	$6,259,000	$6,259,000	4,073,000	36,695,000	1,195,000	11,427,000	48,122,000	9,301,000	66,233,000
1927	.....	17,796,000	.....	6,259,000	628,000	36,674,000	184,000	11,611,000	48,285,000	10,265,000	66,081,000
1928	.....	17,481,000	.....	6,259,000	628,000	36,642,000	184,000	11,795,000	48,437,000	11,240,000	65,918,000
1929	.....	17,166,000	.....	6,259,000	628,000	36,600,000	184,000	11,979,000	48,579,000	12,225,000	65,745,000
1930	.....	16,851,000	.....	6,259,000	628,000	36,547,000	184,000	12,163,000	48,710,000	12,221,000	65,561,000
1931	.....	16,536,000	.....	6,259,000	628,000	36,484,000	184,000	12,347,000	48,831,000	12,227,000	65,367,000
1932	326,000	16,547,000	10,874,000	17,133,000	4,640,000	40,422,000	1,360,000	13,707,000	54,129,000	26,116,000	70,676,000
1933	.....	16,227,000	.....	17,133,000	628,000	40,271,000	184,000	13,891,000	54,162,000	27,217,000	70,389,000
1934	.....	15,907,000	.....	17,133,000	628,000	40,110,000	184,000	14,075,000	54,185,000	28,326,000	70,092,000
1935	.....	15,587,000	.....	17,133,000	628,000	39,938,000	184,000	14,259,000	54,197,000	29,446,000	69,784,000
1936	.....	15,267,000	7,700,000	24,833,000	3,618,000	42,746,000	1,062,000	15,321,000	58,067,000	38,276,000	73,334,000
1937	.....	14,947,000	.....	24,833,000	628,000	42,504,000	184,000	15,505,000	58,009,000	39,466,000	72,956,090
1938	.....	14,627,000	.....	24,833,000	628,000	42,252,000	184,000	15,689,000	57,941,000	40,666,000	72,568,000
1939	.....	14,307,000	.....	24,833,000	628,000	41,989,000	184,000	15,873,000	57,862,000	41,877,000	72,169,000
1940	.....	13,987,000	.....	24,833,000	628,000	41,716,000	184,000	16,057,000	57,773,000	43,098,000	71,760,000
1941	.....	13,667,000	12,000,000	36,833,000	3,855,000	44,659,000	1,130,000	17,187,000	61,846,000	56,330,000	75,513,000
1942	.....	13,347,000	.....	36,833,000	628,000	44,311,000	184,000	17,371,000	61,682,000	57,626,000	75,029,000
1943	.....	13,027,000	.....	36,833,000	628,000	43,952,000	184,000	17,555,000	61,507,000	58,933,000	74,534,000
1944	.....	12,707,000	.....	36,833,000	628,000	43,583,000	184,000	17,739,000	61,322,000	60,250,000	74,029,000
1945	.....	12,387,000	12,000,000	48,833,000	4,482,000	47,057,000	1,313,000	19,052,000	66,109,000	73,578,000	78,496,000
1946	.....	12,067,000	.....	48,833,000	628,000	46,602,000	184,000	19,236,000	65,838,000	74,981,000	77,905,000
1947	.....	11,747,000	.....	48,833,000	628,000	46,136,000	184,000	19,420,000	65,556,000	76,395,000	77,303,000
1948	.....	11,427,000	.....	48,833,000	628,000	45,660,000	184,000	19,604,000	65,264,000	77,819,000	76,691,000
1949	.....	11,107,000	.....	48,833,000	628,000	45,173,000	184,000	19,788,000	64,961,000	79,254,000	76,068,000
1950	.....	10,787,000	.....	48,833,000	628,000	44,676,000	184,000	19,971,000	64,647,000	80,699,000	75,435,000

OPERATING STATISTICS—GROSS OPERATING REVENUE AND OPERATING INCOME

Column 18. The population of Detroit is estimated to be 1,000,000 in 1920 and 2,000,000 in 1950. It is assumed that the growth will be in equal yearly increments. The figures shown in this column represent the average estimated population in each year from 1922 to 1950 inclusive.

Column 19. The revenue rides per capita per annum are estimated to be 370 in 1920 and 400 in 1950 and to grow in equal increments of one ride per capita each year.

Column 20. The total revenue passengers per annum are obtained by multiplying columns 18 and 19.

Column 21. The estimated gross operating revenue is calculated by multiplying column 20 by five cents giving the result in dollars per annum. Five cents is here assumed as the average fare per revenue passenger throughout the twenty-nine year period.

Column 22. The operating income is based on an operating ratio of 70 per cent for the years 1922 to 1931 inclusive, on 71 per cent for 1932 to 1935 and on 72 per cent for the subsequent period. In other words, column 22 is 30 per cent, 29 per cent and 28 per cent of column 21 for the above intervals. The operating expenses include 18 per cent of the gross operating revenue from 1922 to 1931, 19 per cent from 1932 to 1935 and 20 per cent from 1936 to 1950, to provide for maintenance and depreciation.

OPERATING STATISTICS—GROSS OPERATING REVENUE AND OPERATING INCOME

Calendar Years	Population	Revenue Rides per Capita per Annum	Revenue Passengers per Annum	Gross Operating Revenue	Operating Income
Column Numbers	18	19	20	21	22
1922	1,066,000	372	397,000,000	$19,850,000	$5,955,000
1923	1,100,000	373	410,000,000	20,500,000	6,150,000
1924	1,133,000	374	424,000,000	21,200,000	6,360,000
1925	1,166,000	375	438,000,000	21,900,000	6,570,000
1926	1,200,000	376	452,000,000	22,600,000	6,780,000
1927	1,233,000	377	466,000,000	23,300,000	6,990,000
1928	1,266,000	378	479,000,000	23,950,000	7,185,000
1929	1,300,000	379	493,000,000	24,650,000	7,395,000
1930	1,333,000	380	507,000,000	25,350,000	7,605,000
1931	1,366,000	381	521,000,000	26,050,000	7,815,000
1932	1,400,000	382	535,000,000	26,750,000	7,760,000
1933	1,433,000	383	549,000,000	27,450,000	7,950,000
1934	1,466,000	384	563,000,000	28,150,000	8,164,000
1935	1,500,000	385	578,000,000	28,900,000	8,381,000
1936	1,533,000	386	592,000,000	29,600,000	8,288,000
1937	1,566,000	387	606,000,000	30,300,000	8,484,000
1938	1,600,000	388	621,000,000	31,050,000	8,694,000
1939	1,633,000	389	636,000,000	31,800,000	8,904,000
1940	1,666,000	390	650,000,000	32,500,000	9,100,000
1941	1,700,000	391	665,000,000	33,250,000	9,305,000
1942	1,733,000	392	680,000,000	34,000,000	9,520,000
1943	1,766,000	393	694,000,000	34,700,000	9,716,000
1944	1,800,000	394	709,000,000	35,450,000	9,926,000
1945	1,833,000	395	724,000,000	36,200,000	10,136,000
1946	1,866,000	396	739,000,000	36,950,000	10,346,000
1947	1,900,000	397	755,000,000	37,750,000	10,570,000
1948	1,933,000	398	770,000,000	38,500,000	10,780,000
1949	1,966,000	399	785,000,000	39,250,000	10,990,000
1950	2,000,000	400	800,000,000	40,000,000	11,200,000

INTEREST AND SINKING FUND

Column 23. This column shows the interest on the Company's total outstanding bonds payable at the end of each year, the rate being assumed at five per cent.

Column 24. This column shows the interest on the Company's outstanding junior securities payable at the end of each year the rate being assumed at six per cent.

Column 25. This column shows the interest on the City's outstanding bonds payable at the end of each year, the rate being assumed at five per cent.

Column 26. This column shows the interest on the City's reinvested earnings payable at the end of each year, the rate being assumed at five per cent.

Column 27. This column shows the amount set aside out of operating income to retire all bonds, City and Company, through the application of the sinking fund, at the end of each year. The equity in the property represented by the amounts in this column reverts automatically to the City thereby reducing the purchase price (column 17).

Column 28. This column is the sum of columns 23 to 27 inclusive and represents the total deductions which must be made from the operating income each year in order to arrive at the net divisible surplus.

INTEREST AND SINKING FUND

Calendar Year	Interest on Company's Bonds 5 per cent	Interest on Company's Junior Securities 6 per cent	Interest on City's Bonds 5 per cent	Interest on City's Reinvested Earnings 5 per cent	Sinking Fund (Bond Retirement)	Total Deductions from Operating Income
Column Numbers	23	24	25	26	27	28
1922	$1,650,000	$581,000	$585,000	. . .	$745,000	$3,561,000
1923	1,654,000	592,000	575,000	. . .	755,000	3,576,000
1924	1,657,000	603,000	566,000	. . .	766,000	3,592,000
1925	1,660,000	614,000	556,000	. . .	776,000	3,606,000
1926	1,835,000	686,000	906,000	$313,000	964,000	4,704,000
1927	1,834,000	697,000	890,000	313,000	975,000	4,709,000
1928	1,832,000	708,000	874,000	313,000	985,000	4,712,000
1929	1,830,000	719,000	858,000	313,000	996,000	4,716,000
1930	1,827,000	730,000	843,000	313,000	1,006,000	4,719,000
1931	1,824,000	741,000	827,000	313,000	1,017,000	4,722,000
1932	2,021,000	822,000	827,000	857,000	1,099,000	5,626,000
1933	2,014,000	834,000	811,000	857,000	1,109,000	5,625,000
1934	2,005,000	845,000	795,000	857,000	1,120,000	5,622,000
1935	1,997,000	856,000	779,000	857,000	1,130,000	5,619,000
1936	2,137,000	919,000	763,000	1,242,000	1,190,000	6,251,000
1937	2,125,000	930,000	747,000	1,242,000	1,200,000	6,244,000
1938	2,112,000	941,000	732,000	1,242,000	1,211,000	6,238,000
1939	2,099,000	952,000	715,000	1,242,000	1,221,000	6,229,000
1940	2,085,000	963,000	699,000	1,242,000	1,232,000	6,221,000
1941	2,233,000	1,031,000	683,000	1,842,000	1,296,000	7,085,000
1942	2,215,000	1,042,000	667,000	1,842,000	1,307,000	7,073,000
1943	2,197,000	1,053,000	651,000	1,842,000	1,317,000	7,060,000
1944	2,179,000	1,064,000	635,000	1,842,000	1,328,000	7,048,000
1945	2,352,000	1,143,000	619,000	2,442,000	1,403,000	7,959,000
1946	2,330,000	1,154,000	603,000	2,442,000	1,414,000	7,943,000
1947	2,306,000	1,165,000	587,000	2,442,000	1,424,000	7,924,000
1948	2,283,000	1,176,000	571,000	2,442,000	1,435,000	7,907,000
1949	2,258,000	1,187,000	555,000	2,442,000	1,445,000	7,887,000

DISTRIBUTION OF NET DIVISIBLE SURPLUS

Column 29. The net divisible surplus, shown in this column is the amount remaining after deducting column 28 from the operating income, column 22.

Column 30. This column shows the Company's share in the net divisible surplus and is 50 per cent of the same unless the amount so established makes the Company's total income more than eight per cent on the par value of the Company's then outstanding securities. All amounts above this eight per cent are allotted to the City in addition to the 50 per cent of the net divisible surplus otherwise specified.

Column 31. This column is the sum of columns 23, 24 and 30, and represents the total amounts paid each year out of the operating income to the Company.

Column 32. This column shows the actual rate of return, each year, on the Company's total outstanding securities.

Column 33. This column shows the City's share in the net divisible surplus and is 50 per cent of same or more in accordance with the explanation given in Column 30.

Column 34. This column is the sum of columns 25, 26 and 33 and represents the total amounts paid to the City each year out of the operating income.

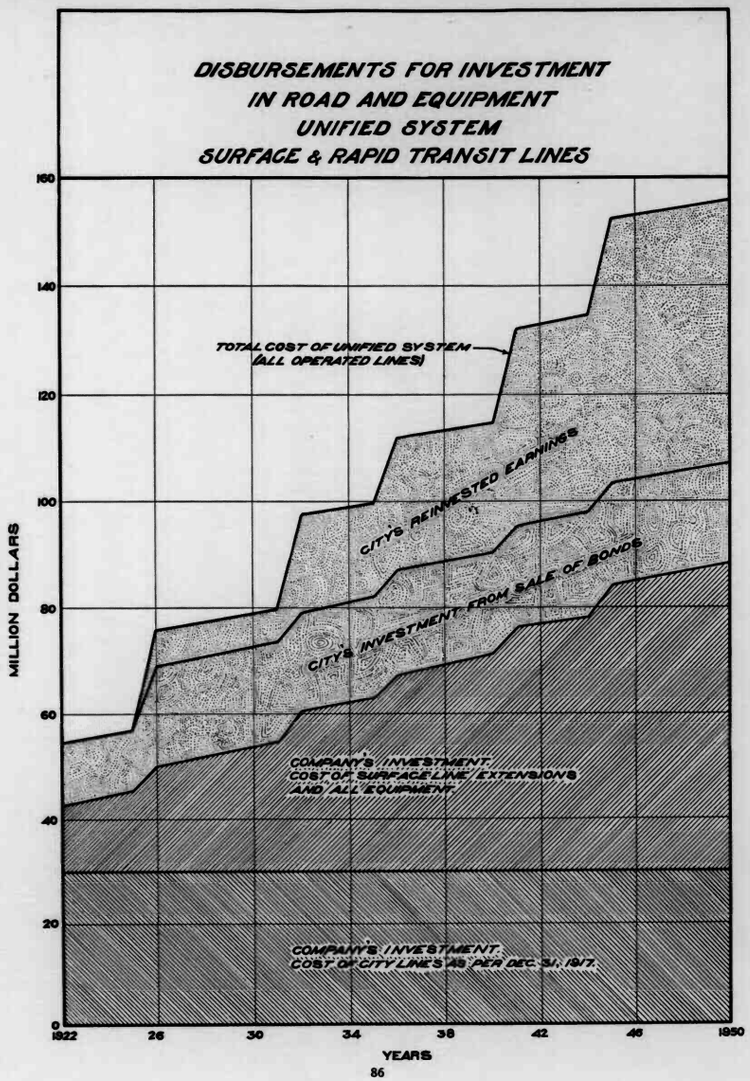
Column 35. This column is the actual rate of return each year on the City's total of outstanding bonds and reinvested earnings.

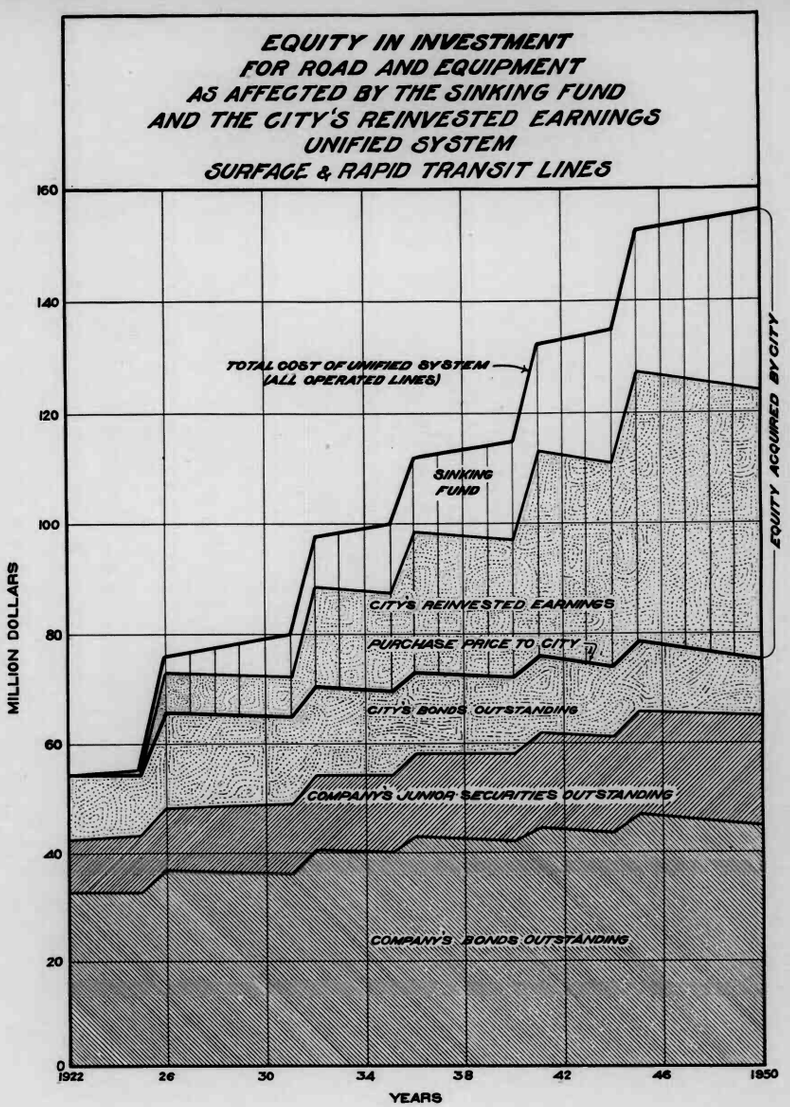
Column 36. This column shows the amount of the traction fund which is assumed to be created by the accumulation of the City's uninvested earnings with interest at four per cent as explained in column 9.

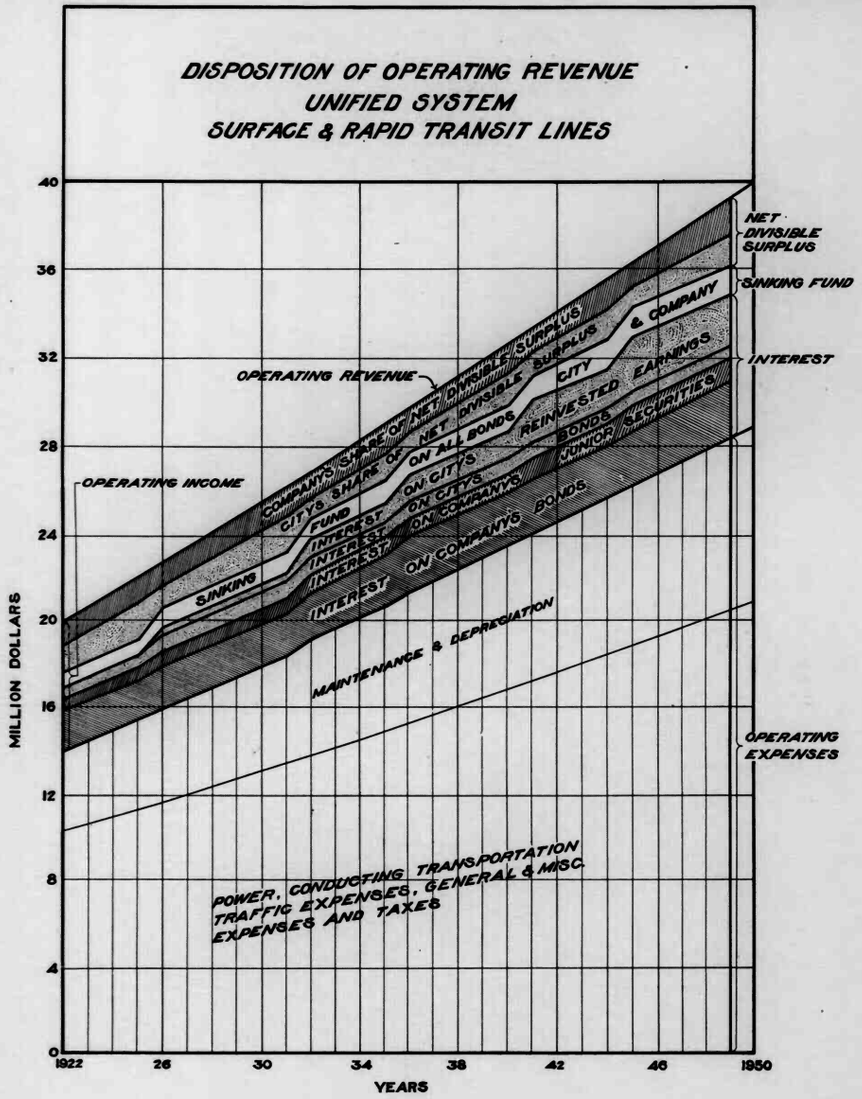
These sums in column 36 if deducted from the purchase price, column 17, would show the actual amount of additional cash in any year, which the City would have to pay to own the unified system, free of all debt.

DISTRIBUTION OF NET DIVISIBLE SURPLUS—TRACTION FUND

Calendar Year	Net Divisible Surplus	Company's Share in Divisible Net Surplus	Company's Total Income (Interest and Surplus)	Rate of Return on Company's Outstanding Securities per cent	City's Share in Divisible Net Surplus	City's Total Income (Interest and Surplus)	Rate of Return on City's Outstanding Bonds and Reinvested Income per cent	City's Uninvested Earnings (Cumulative with 4 per cent)
Column Nos.	29	30	31	32	33	34	35	36
1922	$2,394,000	$1,183,000	$3,414,000	8.00	$1,211,000	$1,796,000	15.35	. . . .
1923	2,574,000	1,190,000	3,436,000	8.00	1,384,000	1,959,000	17.02	. . . .
1924	2,768,000	1,196,000	3,456,000	8.00	1,572,000	2,138,000	18.90	. . . .
1925	2,964,000	1,201,000	3,475,000	8.00	1,763,000	2,319,000	20.90	. . . .
1926	2,076,000	1,038,000	3,559,000	7.39	1,038,000	2,257,000	9.27	. . . .
1927	2,281,000	1,140,000	3,671,000	7.61	1,141,000	2,344,000	9.76	. . . .
1928	2,473,000	1,236,000	3,776,000	7.80	1,237,000	2,424,000	10.20	. . . .
1929	2,679,000	1,339,000	3,888,000	8.00	1,340,000	2,511,000	10.72	. . . .
1930	2,886,000	1,340,000	3,897,000	8.00	1,546,000	2,702,000	11.68	. . . .
1931	3,093,000	1,341,000	3,906,000	8.00	1,752,000	2,892,000	12.69	. . . .
1932	2,134,000	1,067,000	3,910,000	7.22	1,067,000	2,751,000	8.18	. . . .
1933	2,335,000	1,167,000	4,015,000	7.41	1,168,000	2,836,000	8.51	. . . .
1934	2,542,000	1,217,000	4,121,000	7.61	1,271,000	2,923,000	8.86	. . . .
1935	2,762,000	1,381,000	4,234,000	7.82	1,381,000	3,017,000	9.22	. . . .
1936	2,037,000	1,018,000	4,074,000	7.02	1,019,000	3,024,000	7.54	$1,107,000
1937	2,240,000	1,120,000	4,175,000	7.21	1,120,000	3,109,000	7.82	1,151,000
1938	2,456,000	1,228,000	4,281,000	7.39	1,228,000	3,202,000	8.12	1,197,000
1939	2,675,000	1,337,000	4,388,000	7.59	1,338,000	3,295,000	8.42	1,245,000
1940	2,879,000	1,439,000	4,487,000	7.77	1,440,000	3,381,000	8.72	1,295,000
1941	2,220,000	1,110,000	4,374,000	7.07	1,110,000	3,635,000	7.20	2,687,000
1942	2,447,000	1,223,000	4,480,000	7.26	1,224,000	3,733,000	7.45	2,794,000
1943	2,656,000	1,328,000	4,578,000	7.45	1,328,000	3,821,000	7.67	2,906,000
1944	2,878,000	1,439,000	4,682,000	7.64	1,439,000	3,916,000	7.91	3,023,000
1945	2,177,000	1,088,000	4,583,000	6.94	1,089,000	4,150,000	6.78	4,359,000
1946	2,403,000	1,201,000	4,685,000	7.12	1,202,000	4,247,000	6.98	8,064,000
1947	2,646,000	1,323,000	4,794,000	7.32	1,323,000	4,352,000	7.20	12,031,000
1948	2,873,000	1,436,000	4,895,000	7.50	1,437,000	4,450,000	7.39	16,278,000
1949	3,103,000	1,551,000	4,996,000	7.69	1,552,000	4,549,000	7.60	20,811,000
1950	. . . .	. . . .	. . . .	. . .	. . . .	. . . .	. . .	25,542,000


DISBURSEMENTS FOR INVESTMENT
IN ROAD AND EQUIPMENT
UNIFIED SYSTEM
SURFACE & RAPID TRANSIT LINES
MILLION DOLLARS
0
20
40
60
80
100
120
140
160
1922
26
30
34
38
42
46
1950
YEARS
TOTAL COST OF UNIFIED SYSTEM (ALL OPERATED LINES)
CITY'S REINVESTED EARNINGS
CITY'S INVESTMENT FROM SALE OF BONDS
COMPANY'S INVESTMENT. COST OF SURFACE LINE EXTENSIONS AND ALL EQUIPMENT.
COMPANY'S INVESTMENT. COST OF CITY LINES AS PER DEC. 31, 1917.


EQUITY IN INVESTMENT
FOR ROAD AND EQUIPMENT
AS AFFECTED BY THE SINKING FUND
AND THE CITY'S REINVESTED EARNINGS
UNIFIED SYSTEM
SURFACE & RAPID TRANSIT LINES
MILLION DOLLARS
0
20
40
60
80
100
120
140
160
1922
26
30
34
38
42
46
1950
YEARS
TOTAL COST OF UNIFIED SYSTEM (ALL OPERATED LINES)
SINKING FUND
CITY'S REINVESTED EARNINGS
PURCHASE PRICE TO CITY
CITY'S BONDS OUTSTANDING
COMPANY'S JUNIOR SECURITIES OUTSTANDING
COMPANY'S BONDS OUTSTANDING
EQUITY ACQUIRED BY CITY



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COMPARISON OF TYPICAL ALTERNATIVE FINANCIAL PLANS

Investment Per Capita Compared With Other Cities

The perusal of the following statistical data will be helpful in judging of the economy of the traction system proposed in this Report.

The Boston unified surface, elevated and subway system in 1907 served a population of 1,016,395 and had invested in its transportation system $65,979,896 or $65.00 per capita.

In 1916, Boston had invested $116,022,000 in its unified transportation system serving a population of 1,244,645, or the investment per capita increased to $93.00.

In 1916, Chicago served its population of 2,500,000 with competing surface and elevated systems, representing conservatively a valuation of $220,000,000 of which $150,000,000 is the purchase price of the surface car system under agreement with the City under public regulation, and $70,000,000 is a conservative valuation of the elevated lines made by the Chicago Traction and Subway Commission. This means an investment of $88.00 per capita of population served. The unified system, surface, elevated and subway recommended by the Traction and Subway Commission for 1937 would involve an investment of $102.00 per capita of population served.

Plan A, which is shown in detail and recommended in this report, contemplates an initial investment by 1922 of $54,380,000 for a population of 1,066,000, or $51.00 per capita. By 1942 an investment of $132,655,000 is contemplated for a population of 1,733,000, or $76.50 per capita of population. By 1950, $156,134,000 is invested, or $78.00 per capita under this plan.

Considering the physical conditions of Boston and Detroit, the relative expenditure per capita in Detroit seems reasonable, being lower on account of ease of construction, the level territory and the absence of the obstructions by hills, rivers and extremely narrow streets, which occur in Boston. The reason for the cost being lower than Chicago is that instead of two extensive competitive systems forming the basis of a unified system, Detroit now has the opportunity to avoid duplication of surface and rapid transit lines in the plan here laid out, which with the more compact and evenly distributed residential and occupational districts reduces the necessary investment.

The estimates of cost for the different lines proposed in Detroit are shown in Appendix VI.

Three typical plans in which various important factors have been varied may be described and compared as follows:

Plan A

Plan A contemplates an adequate but conservative building program, an average uniform fare of five cents throughout the period, with free transfers between all lines. A first class service is allowed for in the operating expense. The interest charges and return to the City and Company are kept within reasonable limits, but such as will permit of the sale of securities, namely, showing a return equal to from 1⅓ to 1½ times the interest requirements. The net surplus is of sufficient size to insure the payment of all interest charges, even if the actual results of operation should deviate to some extent, as may be expected, from the assumed conditions of traffic used in estimating the return under this financial plan.

Plan B

A number of plans based upon the selling of six tickets for 25 cents and universal transfers were worked out, but with unsatisfactory results. These plans are grouped under Plan B. A curtailed building program was here assumed and the investment of the City was reduced to $53,663,000 by 1950 against $68,050,000 under Plan A. On account of the decrease in the surplus, Plan B involved the issuance by the City of $25,533,000 bonds as against $19,217,000 under Plan A. The security of the bondholders as to their interest is not well protected with this lower fare under fluctuating conditions of traffic even though a curtailed service was assumed in Plan B.

This type of plan results in lack of financial strength, which makes the sale of the securities very difficult. It is also believed, that Plan B would be unsatisfactory to the public both as to the extent of operated trackage and as to frequency of service.

Plan C

In a series of tables, which may be called Plan C, curtailment of the building program from Plan A was assumed the same as under Plan B. The fare charged was taken at six tickets for 25 cents, as in Plan B. The service assumed in this type of plan was equal to that of Plan A. This results in an annual deficit to be made up by the City, if all interest charges are to be met and the Company is to receive a minimum return of seven per cent on its outstanding securities. This deficit would amount to from $1,187,000 to $2,890,000 annually. There being no other return on the City's investment than actual interest on securities issued under Plan C the whole cost of constructing the rapid transit lines, $53,663,000, must be raised from the sale of bonds issued by the City.

These results demonstrate clearly that adequate service cannot be rendered

at less than an average five-cent fare on a self-supporting unified surface and rapid transit system even with the strictest regulation of investment and return.

Realizing the fluctuating character of the cost of service from year to year the plan recommended in this report provides for regulation of the fare to conform to the cost of the service and for the limiting of the return upon the investment to the lowest rate at which capital can be secured from time to time.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In view of the foregoing statement of facts and their analysis covering the existing and indicated future traffic situation in the City of Detroit, as developed by our investigation of 1914 and supplemented and confirmed by a further study in 1917, the following conclusions are reached.

1. Detroit can confidently be expected to grow in the near future to a size which will support and necessitate rapid transit to supplement the existing street car system. A canvass made along conservative lines warrants the assumption that the present population is over 850,000 and perhaps nearly 900,000 in the City and suburbs of Detroit. A future estimate of 1,500,000 population for 1935 and 2,000,000 population in 1950 is reasonable.

2. The existing traffic conditions involving rush hour congestion as well as continuous traffic throughout the day warrant the immediate decision as to the construction of a rapid transit line on at least one thoroughfare in the City. In this connection it is pointed out, that the period necessary for negotiation, detail designing, letting of contracts and construction is probably three years and consequently further congestion must be considered certain before relief can be obtained.

3. Subsequent growth of the City in other districts will require, from time to time, the building of high speed lines, which should form a thoroughly co-ordinated system.

4. The best service for the public at the lowest cost can be supplied by a system of surface and rapid transit lines operated as a unit, with transfers and connections so arranged that for a single fare and free transfers passengers may conveniently utilize both types of transportation.

5. An independent competitive rapid transit system will not offer a satisfactory traffic solution nor can it be financed successfully as a self-supporting enterprise by either the City or the Company.

6. The financing of a unified system by private capital without the City's financial co-operation is not considered practical; nor can such a unified system be financed by the City alone under existing charter limitations as to the permissible amount of the bond issue.

7. In other cities co-operation and partnership between the city and the companies has been secured and tried. Benefiting by the experience thus

obtained and by utilizing charter provisions of the City of Detroit as to the bond issue, a satisfactory combined system of surface and rapid transit lines can be financed and operated and be made self-supporting. Commission control of transportation systems has been developed to a point where the weaknesses and defects of existing regulatory systems have been recognized, so that it is possible to now devise a commission control, which will secure good service and a fair share of the return to the City from the operation of the system.

8. In order to provide adequate facilities and good service in a reasonable time proportionate to the City's growth, the financial burden, even if supported by the City's credit, cannot be carried by the operating revenue without an increase of the fare above that now charged for surface car transportation.

Recommendations

It is, therefore, recommended:

A. That a Unified Surface and Rapid Transit system be planned as the best permanent solution of the City's traffic problem, and that every effort be made to work toward securing such a system with one fare and transfers between all lines.

That to this end a partnership agreement be entered into between the City of Detroit and a Company formed to take over the city lines of the Detroit United Railway; which partnership shall provide for the City to finance, construct and own the structures of the rapid transit lines, and for the Company to finance and construct the surface line extensions and to supply all the equipment for both surface and rapid transit lines.

This partnership agreement to further provide for the operation by the Company of the entire system under a terminable license and subject to supervision as to financing, construction and service rendered, by the Board of Street Railway Commissioners. The financial details of the proposed agreement are treated under the "Financial Plan."

B. That a policy be decided upon of building subways only in the congested centers of the City and that rapid transit lines be extended through the outlying districts by a system of overhead tracks placed upon private right-of-way, or, where the streets are sufficiently wide to permit of a single column structure in the center of the street, without obstruction of light and access to the adjoining property, that this method be followed.

C. That negotiations be at once commenced with the present owners of the surface lines to the end of accomplishing recommendation "A". That simultaneously the necessary legal steps, surveys, and detail plans for a north and south rapid transit line on Woodward avenue, and an east and west rapid

transit line on or near Michigan-Gratiot-Forest avenues be made, so that upon the termination of the war, construction could immediately begin.

So much time has been required in other cities for the necessary preliminary work, legal agreements, surveys, acquisition of right-of-way, design of structures, etc., that all such matters should be taken up as soon as practicable and worked out in final form. It is pointed out that if these matters are neglected or postponed until normal economic conditions are restored, the ensuing period of reestablished activity will produce traffic congestion far worse than any yet experienced in Detroit.

D. That the necessary legal steps be taken for securing the various additional powers and stipulating the functions of the Commissioners in their regulation and control of the City-Company partnership as will be necessary to fully carry out the plan herein proposed. Whether such matters can be properly provided for in a joint City-Company agreement under the charter amendment of April 7, 1913, or whether a further amendment of the charter is necessary, is a question for decision by the legal advisers of the City and of the Company.

E. That as the charter amendment of April 7, 1913 provides for immediate complete municipal ownership and operation of the system, whereas the plan herein proposed contemplates a preliminary period which may extend over a number of years during which joint City-Company partnership will be in effect, it is obvious that certain additional provisions and possible modifications in the organization of the Board of Street Railway Commissioners as provided for in the amendment will be necessary. It is recommended that if they can be made legally effective and binding, such provisions be incorporated in the City-Company agreement so as to safeguard the interests of the traveling public, of the investors in City-Company securities and of the operating company, during the period of joint partnership.

F. That in the agreement or charter amendment the Commissioners be empowered to approve or disapprove of additional rapid transit lines or street railway extensions or equipment, or both, either on their own initiative or when petitioned by either the City authorities, or by the Company, or by a citizens' committee, so that they are given full control of the "Building Program" such as outlined in this Report.

G. That the agreement or charter amendment for City-Company partnership contain suitable legal powers authorizing the Board of Street Railway Commissioners to supervise and approve the City's necessary traction bond issues and all of the issues of securities by the corporation operating the unified properties. This recommendation being aimed to secure complete uniformity of action and control of both classes of securities.

H. That it shall be mandatory upon the Commissioners to so regulate the charge for fares and transfers on the unified system as to maintain a sound financial condition of the combined and unified properties, as contemplated in the charter provision for municipal ownership. This is necessary to make the securities issued either by the City or the operating company, under the Commissioners' direction and control, salable to the general public.

I. That the Commissioners, in the regulation of fares and the authorizing of construction expenditures, shall be required to aim to maintain the gross operating revenue at such an amount as will not only pay all operating expenses, interest and sinking fund, but also will provide a substantial surplus, so that the City's share in said surplus, plus the bonds which the City can issue under its two per cent limit will meet the construction requirements of the rapid transit lines. The Company's share in this surplus, plus the interest charges on its outstanding securities, shall in each year be not less than an agreed upon minimum per cent on said securities.

J. That an interest reserve fund shall be created by the sale of bonds in sufficient amount to equal three per cent on the outstanding City and Company securities. Said fund to be held by a trustee, who shall invest three-fourths of said fund in United States bonds, and hold one-fourth in cash. This fund is to be drawn upon only to pay interest and dividend charges on the outstanding securities, and then only in the event that the operating income is not sufficient in any one year to meet these charges.

K. That in the event of such a use being made of the interest reserve fund it shall be the duty of the Commissioners to immediately increase the fares, reduce the service or otherwise increase the net income so as to fully reimburse this fund out of the surplus earnings in the next succeeding year.

L. That a purchase price, based upon cost, be fixed upon the surface line system and equipment for surface and rapid transit lines at which price the City, during the term of the agreement, may acquire the property upon suitable notice. That this purchase price shall be based upon a fair value of the Company's surface line system at the time of the agreement, plus the actual additional investment in the property, under commission supervision. That the equity in the property represented by the bonds retired each year shall revert to the City so that through the action of the sinking fund, city ownership of the surface line system shall be added to the city ownership of the rapid transit lines and the ownership of the whole system thus ultimately shall become vested in the City.

APPENDICES

CLASSIFICATION OF PASSENGERS ON DETROIT UNITED RAILWAY CITY LINES FOR ONE REPRESENTATIVE DAY, WEDNESDAY, JUNE 27, 1917

Line	Tickets			Coupons of Interurban Tickets	5 Cent Tickets	Cash Passengers 5 Cents Each	Transfers	Employees	Total Passengers
	6 for 25 cents	7 for 25 cents	8 for 25 cents						
Baker		56,514	2,392		1	3,270	20,978	1,165	84,320
Brush		16,398	554		5	1,159	6,504	415	25,035
Crosstown		34,641	6,438		2	1,367	53,364	1,782	97,594
Davison		23,181	1,094		2	956	8,137	280	33,650
Depot		973	21			378	415	66	1,853
Fort	273	57,329	3,511	955	36	4,756	20,419	2,309	89,588
Fourteenth		58,310	20,737		2	3,582	27,908	1,683	112,322
Grand Belt		38,779	2,552		2	1,360	29,962	1,450	74,105
Hamilton		47,927	594			2,261	15,064	1,866	67,712
Harper		15,395	5,792		1	913	9,281	993	32,375
Jefferson		97,235	2,550	189	314	6,738	33,813	2,184	143,023
Leesville		100				3	57	171	331
Michigan		107,903	4,886	647	436	6,824	41,457	3,450	165,903
Myrtle		17,305	764		1	1,021	5,814	587	25,492
Sherman		23,942	11,847		2	1,386	10,660	1,053	48,890
Springwells		3,191	157			143	2,693	132	6,316
Trumbull		13,302	414		2	484	5,168	525	19,895
Victor		1,965	22		4	140	1,724	93	3,948
Woodward		129,270	1,430	492	67	11,359	44,616	2,502	189,736
Grosse Pointe						3,355		14	3,369
Total City Lines	273	743,660	65,755	2,283	877	51,455	338,034	22,720	1,225,057
Per cent of Total	.0222	60.6655	5.3640	.1862	.0715	4.1975	27.6393	1.8615	100%
Per cent of Cash Passengers	.0315	86.0415	7.6078	.2641	.1014	5.9533			100%
Per cent of Transfer to Cash Passengers							39.20		
Per cent of Employees to Cash Passengers								2.628	

Average fare, including transfers, 2.55 cents. Average fare, not including transfers, 3.53 cents.

APPENDIX I

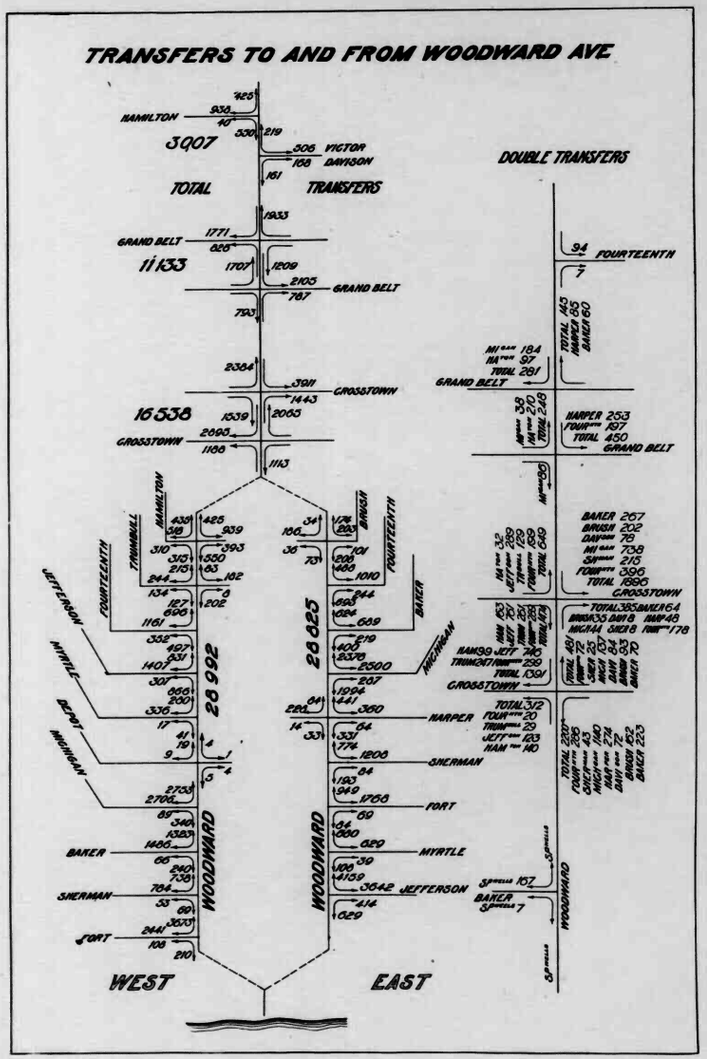
Transfer Count

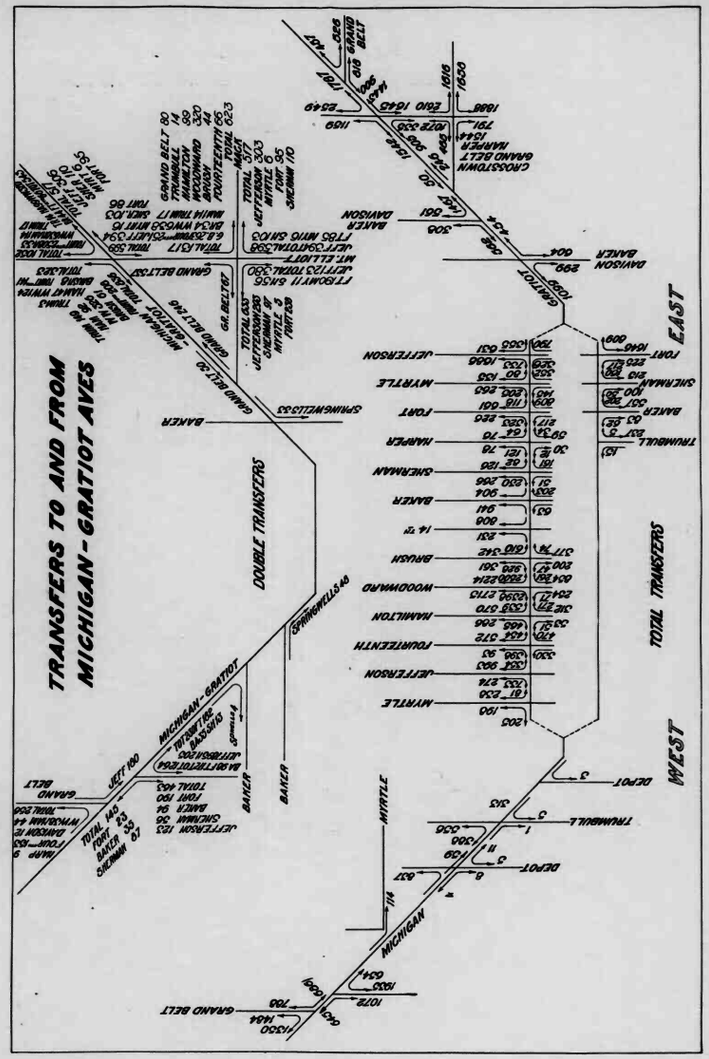
The tables and diagrams here published are based on a transfer count made on Wednesday, June 27, 1917, in co-operation with the Detroit United Railway. The conductors on the cars were instructed to use special care in the handling of the transfer tickets and in the accurate punching of same. These transfer tickets were collected, sorted by routes, by five time periods and by direction. They were then further classified as single and double transfers. The counting and tabulation was then completed to define the number and direction on each line and the total of the transfers on the entire system. The table on page 98 shows the total traffic, on each line, by classes of riders on that representative day, resulting in the classification of 1,225,057 total passengers.

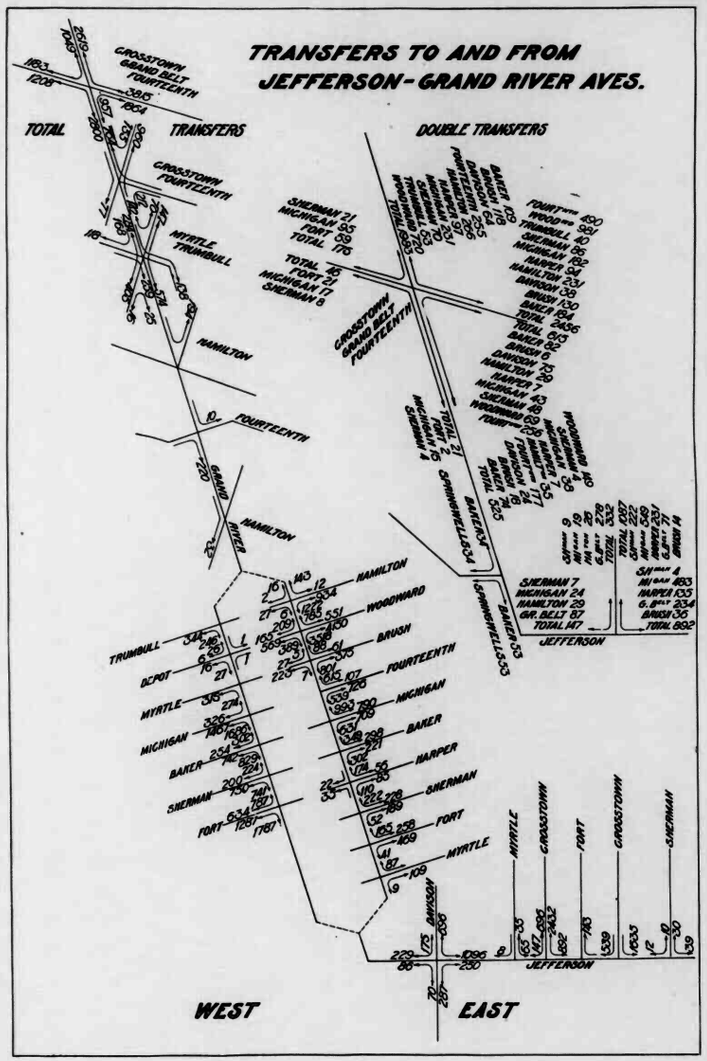
The discussion of the distribution of the transfer passengers on the main lines, and their relation to the total traffic has been given in the text of the Report. Attention is called here to the almost universal use by passengers of the tickets sold at seven for 25 cents. It will be noted that only 273 tickets were used at the price of six tickets for 25 cents, while the number of riders using eight tickets for 25 cents is only about five per cent of the total and only slightly more than the number of five-cent cash passengers. This distribution results in an average fare paid per revenue passenger of 3.53 cents and an average fare per total passengers, including transfers, of 2.55 cents.

The diagrams, page 29, show the total transfer movement on every car line, and also indicate the density of this part of the traffic on each of the surface lines.

Diagrams, pages 100, 101 and 102, show, for the Woodward, Michigan-Gratiot and Jefferson-Grand River lines, the transfer movement at each intersection of these with other car lines. These diagrams visualize the extreme importance of the transfer at the central district, in which area more than one-third of all the transfer movement in the City occurs.


TRANSFERS TO AND FROM WOODWARD AVE
DOUBLE TRANSFERS
TOTAL TRANSFERS
3907
11133
16538
28992
28625
HAMILTON
VICTOR
DAVISON
GRAND BELT
GROSSTOWN
FOURTEENTH
TRIANGLE
BRUSH
BAKER
JEFFERSON
MYRTLE
DEPOT
MICHIGAN
HARPER
SHERMAN
FORT
WOODWARD
WEST
EAST


TRANSFERS TO AND FROM MICHIGAN - GRATIOT AVES
DOUBLE TRANSFERS
TOTAL TRANSFERS
GRAND BELT
MICHIGAN - GRATIOT
BAKER
MYRTLE
MICHIGAN
WEST
EAST



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APPENDIX II

Traffic Studies

The tables shown in this appendix are the result of a study made as to the probable number of passengers, who, in 1916, would have been carried on rapid transit lines in Detroit, if such would have been operated along the routes of some of the existing main surface lines. A summary of these tables is given in the text of the Report, page 32.

On each line the actual distribution of the passengers with regard to their origin and destination was determined first, and from this the number of passengers riding distances of less than one mile, between one and two miles, two and three miles, etc., was calculated. The proportion of the passengers who would use the rapid transit line laid out along the same general route was then figured out with the help of the diagram on page 104, the assumption being made that the same fare is charged upon both surface and rapid transit lines and free transfers given from one system to the other.

The diagram showing the proportion of passengers now using the surface lines, who would be tributary to a rapid transit line similarly located, was determined by the method of time-saving. It has been found in various traffic studies in other cities that the proportion of riders, who will transfer to, or utilize, a rapid transit line in preference to a surface line, bears a definite ratio to the time saved, if the fare and the convenience of transfer are on an equal basis. Thus, for three minutes saved, about eight per cent of the passengers will transfer to or use a rapid transit line; for ten minutes saved, 60 per cent, and for fourteen minutes saved, 80 per cent will transfer to or use a rapid transit line. The time-saving above mentioned is a net saving in every case, proper allowance being made for the time of transfer, waiting for cars, walking, etc. In this study it has been assumed that the speed of the surface cars is nine miles per hour on an average and that the average speed on the rapid transit trains is 16 miles per hour.

The detailed traffic count made in 1914 was used as the basis of these tables and an increase proportionate to the increased traffic in 1916 was prorated and distributed along the whole line. The accuracy of this method was satisfactorily tested by comparison with traffic counts made during 1916 by the Detroit United Railway.

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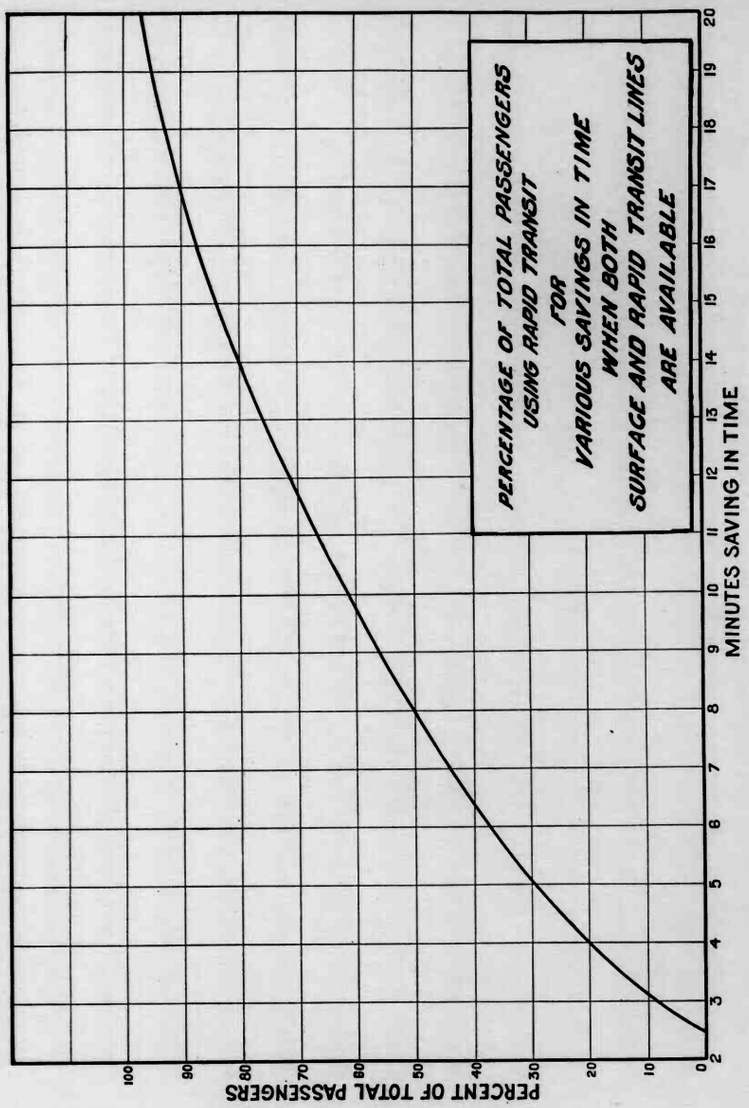


DETROIT TRAFFIC STUDIES—1916

CROSSTOWN LINE

	Actual Number of Passengers on Surface Line	Estimated Rapid Transit Passengers	
		Per cent	Number
Number of passengers riding less than 1 mile	15,023,381	8	1,200,000
Number of passengers riding between 1 and 2 miles	9,140,000	24	2,200,000
Number of passengers riding between 2 and 3 miles	6,388,000	45	2,870,000
Number of passengers riding between 3 and 4 miles	4,646,000	62	2,870,000
Number of passengers riding between 4 and 5 miles	3,886,000	76	2,960,000
Number of passengers riding between 5 and 6 miles	1,594,000	87	1,390,000
Number of passengers riding between 6 and 7 miles	800,000	95	760,000
TOTAL	41,477,381	34.4	14,250,000
Average haul	2.05 miles	...	3.3 miles

FORT LINE

	Actual Number of Passengers on Surface Line	Estimated Rapid Transit Passengers	
		Per cent	Number
Number of passengers riding less than 1 mile	4,832,003	8	386,000
Number of passengers riding between 1 and 2 miles	6,466,000	24	1,550,000
Number of passengers riding between 2 and 3 miles	8,056,000	45	3,630,000
Number of passengers riding between 3 and 4 miles	5,720,000	62	3,550,000
Number of passengers riding between 4 and 5 miles	3,020,000	76	2,300,000
Number of passengers riding between 5 and 6 miles	4,346,000	87	3,780,000
Number of passengers riding between 6 and 7 miles	156,000	95	148,000
Number of passengers riding over 7 miles	160,000	100	160,000
TOTAL	32,756,003	47.5	15,504,000
Average haul	2.81 miles	...	3.72 miles

JEFFERSON-GRAND RIVER LINE

	Actual Number of Passengers on Surface Lines	Estimated Rapid Transit Passengers	
		Per cent	Number
Number of passengers riding less than 1 mile	7,684,542	8	630,000
Number of passengers riding between 1 and 2 miles	10,284,723	24	2,480,000
Number of passengers riding between 2 and 3 miles	9,058,000	45	4,080,000
Number of passengers riding between 3 and 4 miles	7,532,000	62	4,660,000
Number of passengers riding between 4 and 5 miles	5,578,000	76	4,240,000
Number of passengers riding between 5 and 6 miles	5,132,000	87	4,480,000
Number of passengers riding between 6 and 7 miles	4,016,000	95	3,800,000
Number of passengers riding over 7 miles	1,952,000	100	1,952,000
TOTAL	51,237,265	51.2	26,322,000
Average haul	3.26 miles	...	4.5 miles

MICHIGAN—GRATIOT LINE

	Actual Number of Passengers on Surface Line	Estimated Rapid Transit Passengers	
		Per cent	Number
Number of passengers riding less than 1 mile	8,901,452	8	710,000
Number of passengers riding between 1 and 2 miles	11,498,000	24	2,710,000
Number of passengers riding between 2 and 3 miles	11,260,000	45	5,060,000
Number of passengers riding between 3 and 4 miles	9,902,000	62	6,150,000
Number of passengers riding between 4 and 5 miles	8,380,000	76	6,380,000
Number of passengers riding between 5 and 6 miles	5,904,000	87	5,140,000
Number of passengers riding between 6 and 7 miles	1,120,000	95	1,050,000
Number of passengers riding over 7 miles	2,296,000	100	2,296,000
Total	59,261,452	49.6	29,506,000
Average haul	3.11 miles	...	4.22 miles

WOODWARD AVE. LINE

	Actual Number of Passengers on Surface Lines	Estimated Rapid Transit Passengers	
		Per cent	Number
Number of passengers riding less than 1 mile	11,643,539	8	940,000
Number of passengers riding between 1 and 2 miles	16,080,000	24	3,880,000
Number of passengers riding between 2 and 3 miles	11,860,000	45	5,340,000
Number of passengers riding between 3 and 4 miles	10,560,000	62	6,560,000
Number of passengers riding between 4 and 5 miles	7,420,000	76	5,640,000
Number of passengers riding between 5 and 6 miles	7,300,000	87	6,360,000
Number of passengers riding between 6 and 6½ miles	2,800,000	93	2,620,000
Number of passengers riding over 6½ miles	400,000	95	380,000
Total	68,063,539	46.7	31,720,000
Average haul	2.81 miles	...	3.85 miles

APPENDIX III

D. U. R. Traffic 1915-1916

The traffic figures of the Detroit United Railway city lines have been published in detail in the 1915 Report on pages 280 to 285, giving the statistics from 1904 to 1914. The same information is here brought up to date, *i. e.*, the statistics for 1915 and 1916 are given.

OPERATING STATISTICS OF THE DETROIT UNITED RAILWAY

1915

Name of Line	Passengers		Car Miles	Car Hours
	Total	Revenue		
Baker	27,305,357	19,699,370	2,298,146	267,098
Brush	6,997,949	5,074,229	618,364	80,897
Crosstown	33,529,603	14,210,222	2,640,262	285,338
Davidson—S. Chene	1,690,741	838,482	197,116	22,709
Depot—Third St.	764,770	502,887	121,170	21,135
Fort	27,721,424	20,116,558	2,788,608	295,925
Fourteenth	34,953,415	24,776,872	3,975,638	430,746
Grand Belt	4,425,432	2,396,452	379,116	43,045
Grosse Pointe	1,151,803	1,145,829	195,111	13,384
Hamilton	15,055,605	11,281,644	1,002,855	173,930
Harper	10,400,515	7,202,518	1,083,307	130,085
Jefferson	41,101,130	30,103,820	4,048,565	417,138
Leesville	0	0	0	0
Michigan	50,436,332	37,114,692	4,536,466	504,759
Myrtle	7,225,279	5,381,713	800,851	92,371
Sherman	16,026,359	12,276,378	2,092,753	222,581
Springwells	1,523,794	943,992	268,078	28,222
Trumbull	7,049,226	4,492,109	600,191	75,505
Victor	1,443,829	712,610	118,546	12,225
Woodward	55,207,827	41,543,391	5,330,709	550,219
Total	344,010,390	240,245,768	33,696,052	3,667,312

OPERATING STATISTICS OF THE DETROIT UNITED RAILWAY

1916

Name of Line	Passengers		Car Miles	Car Hours
	Total	Revenue		
Baker	32,431,195	23,347,086	2,582,987	299,354
Brush	8,810,687	6,373,988	695,190	94,739
Crosstown	41,477,381	17,779,918	3,201,293	355,733
Davidson-Chene	4,756,569	3,133,570	463,556	57,292
Depot-Third St.	1,751,889	1,560,564	198,305	27,058
Fort	32,756,003	24,100,853	3,158,719	342,218
Fourteenth	39,240,273	28,039,417	4,150,376	454,702
Grand Belt	7,637,580	4,252,484	657,470	74,922
Grosse Pointe	1,164,562	1,159,096	226,988	16,179
Hamilton	20,039,338	15,167,260	2,008,482	217,662
Harper	12,099,582	8,243,634	1,247,906	151,440
Jefferson	50,072,693	37,120,393	4,699,912	515,199
Leesville	78,029	29,055	21,679	4,379
Michigan	59,261,462	43,668,555	5,287,001	599,726
Myrtle	7,925,802	5,898,567	828,757	97,693
Sherman	18,655,621	14,182,578	2,284,581	247,445
Springwells	1,880,903	1,025,403	309,749	34,973
Trumbull	7,846,271	5,456,470	621,889	80,259
Victor	1,830,865	916,157	124,513	12,453
Woodward	68,063,539	51,528,693	6,771,293	775,075
TOTAL	417,780,244	292,043,741	39,541,246	4,458,500

APPENDIX IV

D. U. R. Operated Trackage, 1901 to 1916

A tabulated statement of the surface lines in the City of Detroit is given here, showing the increase by years in the length of the operated trackage of the system. The data are from 1901 to 1916, inclusive, giving an average increase per annum of 3.302 miles of single track. It will be noted that 6 miles of single track is added each year to the system in the estimates in this Report. Thus the added facilities contemplated in the building program are on a more liberal scale than those provided for up to the present.

LENGTH OF SINGLE TRACK OF CITY LINES DETROIT UNITED RAILWAY

Year	Length of Single Track Miles *	Increase Over Previous Year Miles	Year	Length of Single Track Miles *	Increase Over Previous Year Miles
1901	178.553	. . .	1909	185.816	.092
1902	177.545	1.008**	1910	187.884	2.068
1903	178.880	1.335	1911	192.670	4.786
1904	180.193	1.313	1912	200.462	7.792
1905	180.123	.070**	1913	200.866	.404
1906	180.401	.278	1914	206.885	6.019
1907	185.579	5.178	1915	210.899	4.014
1908	185.724	.145	1916	228.083	17.184

Average increase, 1901-1916, per annum, 3.302 miles of single track.
* Exclusive of Car House and Power House tracks. ** Decrease.

APPENDIX V

The Method Used to Predict the Future Population of Detroit

General

The statistical numbers are represented in graphic form by a series of points referred to the time abscissa. If the points so defined are connected in succession by straight lines, these latter will give a polygonal contour.

The problem of prediction is to derive from this polygon the value of the ordinate at some future timepoint.

The common practice of making the prediction consists in drawing a smooth curve approximating the contour and extending it, according to the taste or judgment of the investigator, to the time limit in question. This method evidently depends upon the individuality of the investigator and actually results in widely divergent predictions, although based on the same data, if the solution is undertaken by several men independently, however competent they may be.

If by the use of complicated analytical work a curve be computed, which actually fits the given points, this curve, as a rule, will be of higher order. The value of the ordinate for a distant abscissa, figured by the formula found for the curve, will represent a prediction contrary to common sense, as proven by many trials in almost every case of this nature.

In the following a different standard solution of the problem will be submitted.

Proposed Method of Prediction

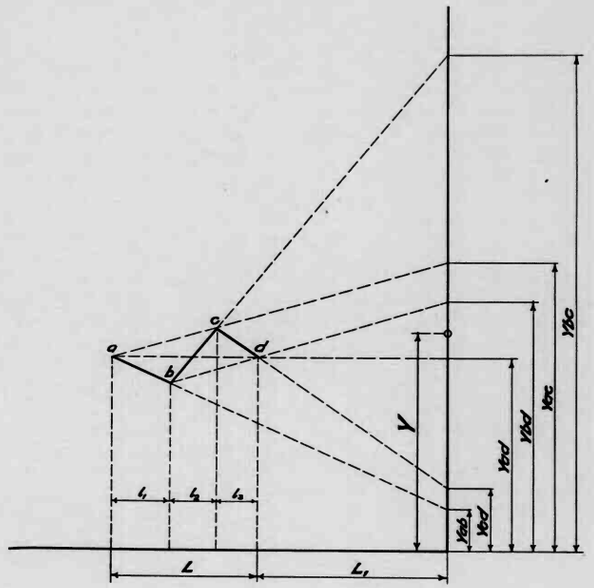
If we have but two observed data, in other words, only two points of the polygon, and not having any idea of the magnitude and time of occurrence of the "forces" which in the future may influence the function sought, the only rational solution of the problem would consist in assuming that the phenomenon, to the timepoint in question, will pursue the straight course defined by connecting the given points.

This solution, which is entirely arbitrary, but which, nevertheless, is the only logical one, would represent the actual facts with a great probability of accuracy if the line would be extended a comparatively short distance only. But it is also evident that this probability diminishes when the extension becomes relatively long.

According to the assumption made, *i. e.*, that we do not know the intensity and time of action of the potential forces governing the statistics, there is no reason to assume that the law of variations of this probabilty shall

not be a linear function, so that if we denote by L the length of the given straight line, and by L_1 the length of the prolongation, then the probability will be measured by the fraction $\frac{L}{L + L_1}$ which tends toward zero if L_1 becomes very large, and is equal unity, when L_1 equals zero, in other words, if the last given point is considered.

Suppose now, that the figure represents a plat of statistical facts, l_1, l_2, l_3, denoting time periods, L being equal to $l_1 + l_2 + l_3$, and L_1 the period for which the prediction is sought. The arithmetic mean of the values of the segments Y_{ab}, Y_{ac}, Y_{bc}, Y_{cd} would furnish the solution Y, if the probabilities of each of the Y_{ab}, etc., values would be the same. But the probability of each value Y_{ab}, Y_{ac}, etc., Y_n, is given by the expression $\frac{L^n}{L_n + L_{1n}}$ where L_n denotes the distance of any pair of points considered and L_{1n} the length of the extension to the future timepoint.



Then the most probable value of the statistical fact at the time of the prediction will be

$$Y = \frac{\sum Y_n \times \frac{L_n}{L_n + L_{1n}}}{\sum \frac{L_n}{L_n + L_{1n}}}$$

giving the length which is the resultant of the weighted individual segments.

The proposed method will give a uniform course in predicting future facts of statistics and the prediction so made should give rational and conservative results, for normal conditions prevailing during the time considered.

Mathematical accuracy is obviously impossible in a problem of the nature here discussed. It is believed, however, that the results obtained by applying the foregoing theory will possess a greater probability than the predictions for future statistics made by other methods in use.

In applying the method here proposed to the prediction of the future growth of the population of cities, the interval, for which the prediction is to be made, should be divided into several parts depending upon the length of this interval, and a prediction should be made for each of these parts in succession so as to eliminate errors as much as possible.

For large American cities a prediction based on early statistics does not lead to good results. These cities, in the last 20-25 years have undergone tremendous changes, due to the exceedingly heavy immigration in recent decades, to the introduction of rapid transit facilities, and also due to the enormous growth of commerce and industries.

The sudden change in conditions is still more marked in the "greater cities" where the population in the recently annexed territories grows out of all previous proportions due largely to the one fare zone system and the extensions of city improvements.

In the prediction made in this Report for the City of Detroit the data previous to 1900 were, therefore, disregarded and it was assumed that in 1920 the one million mark will be reached. The interval between 1920 and 1950 was then divided into three periods, each ten years long, and the prediction for 1930 made. This result was considered as accurate and the further prediction for 1940 made on the basis of data from 1900 to 1930. The 1950 prediction then is the result of the data from 1900 to 1940.

In order to check this method as applied to population growth, a number of figures were made, taking early statistics of the City of London, and more recent statistics of Philadelphia, Manhattan, etc., and predicting the population of these for the timepoint of the last available census. It has been found that the prediction so made fell below the actual by two to ten per cent and this leads to the conclusion that the method here proposed can be considered conservative and safe.

APPENDIX VI

Cost Estimates

The unit prices used in arriving at a fair construction cost are based upon recent figures submitted for work of similar nature in the large eastern cities. It may be stated that a reasonable allowance has been made for the increase in cost of material and labor, considerably in excess of the ante bellum prices. The estimate upon which the financial plan is based can thus be considered safe and within limits of construction costs to be realized in the near future.

UNIT PRICES USED IN ESTIMATING RAPID TRANSIT IMPROVEMENTS FOR THE CITY OF DETROIT

Cost Per Linear Foot of Single Track Structure

Business District Subway	$173.00
Residence District Subway	159.00
Overhead Railway on Street	66.00
Overhead Railway on Private Right-of-Way	53.00
Subway Stations, 250-foot Platforms for double track	75,000.00
Overhead Railway Stations, 250-foot Platforms for double track	40,000.00

Woodward Avenue Route

1.	Atwater Street Stub Terminal		
	Portal construction	$30,000.00	
	Overhead railway	108,000.00	
	Overhead railway station	40,000.00	$178,000.00
2.	Cadillac Square Stub Terminal		
	Complete		300,000.00
3.	Subway from Jefferson to Adams Street, 0.67 mile		
	Double track construction	$1,029,000.00	
	Three stations	225,000.00	
	One transfer station	125,000.00	
	Ducts and pipes	21,000.00	
	Lighting tunnels	20,000.00	
	Sewer construction	175,000.00	1,595,000.00
4.	Subway from Adams Street to North of Grand Boulevard, 2.56 miles		
	Double track construction	$3,645,000.00	
	Five stations	375,000.00	
	Sewer construction	675,000.00	4,695,000.00
5.	Overhead Railway from Grand Boulevard to Manchester Avenue, 3 miles		
	Solid deck construction	$1,680,000.00	
	Six Stations	240,000.00	
	Grand Boulevard portal	70,000.00	
	Real estate	500,000.00	2,490,000.00
	Railroad construction total		$9,258,000.00
	15% for Contingencies and Engineering		1,389,000.00
			$10,647,000.00
	Interest during construction		1,052,000.00
	Total cost		$11,699,000.00

Michigan-Gratiot Route

1.	Subway Under Beech-Adams Streets, from National Avenue to Hastings Street, 1.60 miles		
	Double track construction	$3,120,000.00	
	Three stations	225,000.00	
	One transfer station	150,000.00	
	Real estate	200,000.00	$3,695,000.00
2.	Overhead Railway on Private Right-of-way, Along Michigan Avenue, 5 miles		
	Solid deck structure	$2,750,000.00	
	Eight stations	320,000.00	
	Right-of-way	800,000.00	
	Portal at National Avenue	70,000.00	3,940,000.00
3.	Overhead Railway on Gratiot and Forest Avenues from Hastings Street to Ste. Clair Heights, 4.75 miles		
	Solid deck construction	2,600,000.00	
	Eight stations	320,000.00	
	Portal at Hastings Street	70,000.00	2,990,000.00
			$10,625,000.00
	15% for Contingencies and Engineering		1,594,000.00
			$12,219,000.00
	Interest during construction		1,231,000.00
	Total cost		$13,450,000.00

Jefferson-Fort Route

1.	Subway from Cadillac Square under Congress Street to St. Antoine Street, 0.33 mile		
	Double track construction	$450,000.00	
	Cadillac Square station extension	100,000.00	
	Real estate	200,000.00	$750,000.00
2.	Subway from Woodward Avenue under Fort Street to 3rd Avenue, 0.5 mile		
	Double track construction	$1,150,000.00	
	One station	100,000.00	1,250,000.00
3.	Overhead Railway on Fort Street from Third Avenue to Woodmere Avenue, 4.5 miles		
	Solid deck construction	$2,480,000.00	
	Seven stations	280,000.00	
	Portal at Third Avenue	70,000.00	2,830,000.00
4.	Overhead Railway on Private Right-of-way, Between Congress and Fort Streets, from St. Antoine to Townsend Avenue, Thence on Jefferson Avenue to City Limits		
	Solid deck construction	$3,300,000.00	
	Ten stations	400,000.00	
	Right-of-way	344,000.00	4,044,000.00
			$8,874,000.00
	15% for Contingencies and Engineering		1,320,000.00
			$10,194,000.00
	Interest during construction		1,010,000.00
	Total cost		$11,204,000.00

ADDITIONS AND EXTENSIONS AFTER COMPLETION OF INITIAL BUILDING PROGRAM

Overhead Railway

1.	Woodward Avenue Extension from Manchester Avenue, North		
	6 miles of double track construction	$3,300,000.00	
	10 stations	400,000.00	$3,700,000.00
2.	Gratiot Avenue Extension		
	4½ miles of double track construction	2,500,000.00	
	7 stations	280,000.00	2,780,000.00
3.	Forest Avenue Extension		
	3½ miles of double track construction	2,000,000.00	
	5 stations	200,000.00	2,200,000.00
4.	Fort Street Extension		
	1½ miles of double track construction	1,000,000.00	
	2 stations	80,000.00	1,080,000.00
5.	Michigan Avenue Extension		
	½ mile of double track construction	300,000.00	
	1 station	40,000.00	340,000.00
6.	Grand River Extension		
	3¼ miles of double track construction	1,800,000.00	
	4 stations	160,000.00	1,960,000.00
7.	Jos. Campau, Grand Boulevard and Livernois Route		
	A. Grand Boulevard Subway		
	2¾ miles of construction		4,125,000.00
	B. Jos. Campau Overhead Extension		
	4½ miles of double track construction	2,500,000.00	
	7 stations	280,000.00	2,780,000.00
	C. Livernois Overhead Extension		
	4½ miles of double track construction	2,500,000.00	
	7 stations	280,000.00	2,780,000.00
			$21,745,000.00
	Add for real estate and transfer stations		3,500,000.00
	15% for Contingencies and Engineering		3,750,000.00
	Interest during construction		2,700,000.00
	Total cost		$31,695,000.00

APPENDIX VII

Employment Statistics

The table here published gives the name of the industrial establishments and department stores in Detroit having employed in 1916 more than 500 persons. The number of workers employed in each of these places is stated for the years 1914 and 1916, indicating the rapid growth of the industries in almost every case. Most of these establishments are shown on diagram, page 39, and can be identified by the location given in the table.

The data from which the table was compiled were furnished by the Department of Labor of the State of Michigan.

FACTORIES AND STORES IN DETROIT EMPLOYING OVER 500 WORKERS

NAME	LOCATION	NO. OF WORKERS 1916	1914
Ford Motor Company	Highland Park	30,624	13,515
Packard Motor Car Company	Blvd. & Mc Belt Line	10,693	4,387
Dodge Brothers	Hamtramck	9,781	3,152
Studebaker Corporation	105 Piquette	8,200	6,616
Studebaker Corporation	Plant 3, Clarke & W. Jeff.		
Chalmers Motor Car Company	E. Jeff. & New Belt Line	5,078	2,454
Cadillac Motor Car Company	Factory and General Offices, Cass & Amsterdam	3,984	5,057
Morgan & Wright	Foot of Bellevue	3,603	2,677
Hudson Motor Car Company	Jefferson & Connors Road	3,556	1,005
Timken-Detroit Axle Company	Clark & Oak	3,029	1,483
Burroughs, A. M. Company	Second & Burroughs	2,894	2,043
Detroit Edison Company	18 Wash. Blvd. at State	2,832	....
Northway Motor & Mfg. Co.	Maybery Gd. & G. T. RR.	2,622	1,091
Michigan State Tel. Co.	20 Clifford at Wash. Blvd.	2,533	2,808
Parke-Davis & Company	743 Atwater at McDougall	2,388	2,125
Continental Motors Co.	3001 E. Jeff. and Bezner	2,152	1,041
Detroit Cop. & Brass Rollg. Mills	95 Clark Ave. below Wabash	2,062	1,045
Kelsey Wheel Company	1208 to 1250 Military Ave.	2,041	....
American Car & Fdy. Co.	Russell & Ferry Pen. Car. Dpt.	1,978	....
Maxwell Motor Company	Oakland Avenue	1,924	1,764
Solvay Process Company	Delray	1,691	1,397
Cadillac Motor Car Co. No. 2	Fdy. & Sht. Metal Dept., 500 Tromley	1,607	....
Wilson Body Co. C. R.	Clay and G. T. RR.	1,535	829
Hudson Co. J. L. (Dept. Store)	Gratiot & Farmer	1,494	923
Hupp Motor Car Corporation	Milwaukee & Mt. Elliott	1,406	821
Timken-Detroit Axle Co. No. 2	Waterloo & Detroit RR.	1,356	....
Hayes Mfg. Co.	Maybury Gd. & G. T. RR.	1,347	340
Detroit City Gas Company	Clifford & Washington	1,316	1,164
Detroit Screw Works	Franklin & Riopelle	1,297	370
Murphy Chair Company	D. G. H. & Milwaukee Junct.	1,255	644
Newcomb-Endicott Co. Dpt. Store	190 Woodward Avenue	1,202	1,262

NAME	LOCATION	NO. OF WORKERS 1916	1914
Michigan Malleable Iron Co.	Gould, Anderson & Crossly	1,169	503
Aluminum Castings Co.	Chene & Finley	1,151	358
Detroit Steel Products Co.	2250 E. Gd. Blvd. & Griffen	1,149	596
Cadillac Motor Car Co. No. 3	Body & Trimmings Depts., 900 W. Fort and 23rd	1,051	....
Crowley-Milner Co. Dept. Store	Gratiot, Farmer, Monroe & Library	1,031	765
Briggs Mfg. Co. (Plant A)	Hamtramck, Leuschner Av. & G. T. RR.	1,019	929
Michigan Alkali Co.	Village of Ford	1,012	922
American Lady Corset Co.	West Fort & 6th	1,003	833
Great Lakes Engineering Wks.	River Rouge, foot of Rivard	983	907
Detroit Stove Works	1320-1360 E. Jefferson Ave.	933	785
Saxon Motor Company	Beaufait & Waterloo	930	220
Anderson Electric Car Co.	Clay & Riopelle	915	600
Detroit Lubricator Company	1178 Trumbull & G. T. RR.	904	420
Peninsular Stove Company	W. Fort, 8th & 10th	894	907
Herbert Mfg. Co.	576 Kirby West	867	928
Stearns & Co.	Frederick, Jefferson & Bellevue	853	929
Scotten, Dillon Company	1147 to 1161 W. Fort	847	1,361
Ford Motor Co. (Service Sta.)	1550 Woodward & Boulevard	844	....
Buhl Malleable Company	Adair & Wight	843	625
San Telmo Cigar Mfg. Co.	540 E. Forest Ave.	838	1,184
Diamond Mfg. Co.	Artillery & Muster	799	321
Gen'l Aluminum & Brass Mfg. Co.	East Grd. Blvd. & St. Aubin	741	434
Michigan Copper & Brass Co.	1611 W. Jeff. Avenue	734	315
Michigan Stove Co.	1022 E. Jeff. Avenue & Adair	700	874
Fischer Closed Body Co. (Bch)	Milwaukee & Dequindre	1,374	2,265
Fischer Closed Body Co. (Bch)	Harper & Hastings		
Paige-Detroit Motor Car Co.	McKinstry & W. Fort	656	294
Detroit Creamery Company	Cass & Grand River	650	397
Clayton & Lambert Mfg. Co.	201 Piquette Ave., Trombley & Beaubien	646	87
Michigan Stamping Company	759 Bellevue, Mack Ave. and outer Belt Line	646	327
Wayne Cigar Company	909 St. Aubin & East Forest	625	998
American Blower Company	1400 Russell	621	573
Edmund & Jones Mfg. Co.	436 Lawton Ave.	617	463
Mercier, J. A.	243 Beecher	607	9
Pingree Co., The	102-104 Jefferson	601	539
Pennsylvania Salt Company	Wyandotte	585	514
National Can Company	Milwaukee, Jct. Gd. Blvd. & D. & M. RR.	581	404
Detroit Wire Spring Company	Russell & Westminster Ave.	580	236
Acme White Lead & Color Wks.	Hamtramck, 1740 St. Aubin & M. C. RR.	573	549
Michigan Lubricator Company	661 Beaubien	561	438
Finck & Co., W. M.	1160-1174 Gratiot	559	573
Detroit Forging Co.	120 Mt. Elliott Avenue	559	366
Winkley Company	866 West Warren	554	223
Long Mfg. Company	East Grd. Blvd. & Cameron Ave.	549	264
Chicago Pneumatic Tool Co.	Second & Amsterdam	541	289
Russell Wheel & Fdy. Co.	Chene & Belt Line RR.	534	339
Detroit Pressed Steel Co.	1800 Mt. Elliott Ave.	532	198
Detroit Steel Castings Co.	1243 Michigan Avenue	522	185
Semet-Solvay Company	West Jeff. & Solvay	515	370
Briscoe Mfg. Company	1443 Woodward Av. & Baltimore	515	510
Larned, Carter Co.	Cor. 8th, Howard & Abbott	514	515
Detroit Ship Building Co.	Wyandotte, foot of Orleans	512	216
Fairview Fdy. Company	Foot of Vanilla	506	302
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